THE PHOTOGRAPHY OF PATIENTS

Including Discussions of Basic Photographic and Optical Principles and Infrared Techniques

Publication Number 372
AMERICAN LECTURE SERIES®

A Monograph in
The BANNERSTONE DIVISION *of*
AMERICAN LECTURES IN MEDICAL PHOTOGRAPHY

Edited by

RALPH P CREER

Director Department of Medical Motion Pictures and Television Division of Communications
American Medical Association
Consultant to the Medical Illustration Division
Veterans Administration Washington D C

Plate I Frontispiece: Optimum photoflash technique with a 3/1 lighting ratio was utilized for this 4 x 5-inch Ektachrome record see Chapter VI.

Publication Number 372
AMERICAN LECTURE SERIES®

A Monograph in
The BANNERSTONE DIVISION *of*
AMERICAN LECTURES IN MEDICAL PHOTOGRAPHY

Edited by
RALPH P CREER

Director Department of Medical Motion Pictures and Television Division of Communications
American Medical Association
Consultant to the Medical Illustration Division
Veterans Administration Washington D C

Plate I Frontispiece- Optimum photoflash technique with a 3/1 lighting ratio was utilized for this 4 x 5-inch Ektachrome record see Chapter VI.

CHARLES C THOMAS PUBLISHER
BANNERSTONE HOUSE
301-327 East Lawrence Avenue, Springfield, Illinois, U.S.A

Published simultaneously in the British Commonwealth of Nations by
BLACKWELL SCIENTIFIC PUBLICATIONS LTD., OXFORD, ENGLAND

Published simultaneously in Canada by
THE RYERSON PRESS, TORONTO

Library of Congress Catalog Card Number: 59-14107

First Edition, First Printing, January 1952
Second Edition, First Printing February 1960

With THOMAS BOOKS careful attention is given to all details of manufacturing and design. It is the Publisher's desire to present books that are satisfactory as to their physical qualities and artistic possibilities and appropriate for their particular use. THOMAS BOOKS will be true to those laws of quality that assure a good name and good will.

Printed in the United States of America

PREFACE

THE VALUE of photography in medicine has created a great demand for information about the techniques involved. To ensure the clarity of a routine medical record, to achieve full meaning in a series of progress photographs, or to attain the desired significance in research photography it is necessary to know what a good photograph is and how to make it. Whether the picture is used for archival, teaching, discussion or discovery purposes it must accurately represent the mental image that the sponsor of the photograph had of the original subject. This can only be accomplished through attention to the basic principles of photographic recording.

These principles are simple to apply once they are understood. This book is prepared on the premise that the reader wants to acquire a systematic approach to the photography of patients so that good photographs can be easily made. A practical viewpoint has been adopted and theory has been introduced only when it helps to establish good practice. Simple methods that lead to reasonably good records are described as well as the more advanced techniques for optimum results.

It is assumed that many readers have had no more than the photographic experience of the average snapshotter. In this way the book can be useful to beginners in medical photography. Nevertheless, the discussions are carried to lengths that will provide useful information for those who have had considerable experience in the field. Some of the more theoretical sections are set in small type. In this way the general aspects can first be noted and assimilated, then the fine points can be returned to later.

The material is intended to be useful both to the institutional photographer working in a large department and to the physician making records in his office. Where necessary, the difference in methods is indicated. However, for the most part, the basic approach is the same in both instances. The teacher of medical photography will find the book not only useful in presenting the techniques for photographing patients but also a condensed text on photographic optics and film and paper characteristics, covering the theory most pertinent to his field. A review of color processes is included.

It is not expected that the discussions will all be new to all readers. For example

the physician will not have to be told how to handle patients, but the photographer new to the field will welcome suggestions Or basic optics is applied routinely by the experienced medical photographer· on the other hand, this background will be of value to the physician who wants to learn a little photography And the physician or technician interested only in making useful records with the simplest equipment and the least disruption of routine need only read the sections on simplified techniques Another s viewpoint always provides a new outlook for even the most proficient Thus it is felt that this book offers something for everyone

H L G

Rochester New York

CONTENTS

THE PHOTOGRAPHY OF PATIENTS

Including Discussions of Basic Photographic and Optical Principles and Infrared Techniques

CHAPTER I FUNDAMENTALS

Most of the basic details of making a good photograph are either obvious or generally understood. Nevertheless, it is surprising how often some of the points that make the difference between a good and bad record are overlooked. The reason lies usually in a nonsystematic approach. Accordingly the main considerations are outlined here for guidance

Purpose

The first thing to decide is the intended and probable use of the photograph. For example a teaching illustration has to be more explicit than one to be presented at a seminar or staff conference Indeed, the former application may require several pictures to convey a point that could be covered with one photograph on the latter occasions

Another aspect concerns the progress record. The main purpose here is to help the physician remember how each of numerous patients appeared on a previous visit Such series are also valuable in teaching and in reporting case histories. For all these applications the progress of the patient can best be followed if standard camera viewpoints, lightings, and image scales are adopted. Not only must the first picture be posed correctly but also the requirements of the last in the series should be taken into account. For example in starting a series on plastic surgery of the face the photographer should not just *place* the subject in front of the camera, even though he intends to replace the patient exactly each time He should try at the first sitting to visualize the end result. He should then pose the patient and light the features so as to ensure a final pleasing portrait rather than a "mug shot"

In preparing for publication, economy and brevity ought to be kept in mind. This imposes a need for the maximum story-telling quality in each photograph. Even a routine record to be filed with a patient's case history should be made with other probable uses in mind. The reason for this is that well-illustrated case records form the best possible reservoir of photographs for all medical applications of photography

Such pre-planning may appear tedious and impractical at first glance. Yet it need not be so. It is merely necessary for the physician to remember that he is generally *not* making the photograph *for himself*

Then all he has to do is to momentarily imagine himself presenting the illustration in the way intended This automatically almost ensures the full story telling content

A critical faculty regarding ones own work can be developed through making a careful study of the work of others Perhaps the best way to induce a self-critical frame of mind in this connection is to examine occasionally another s article dealing with a relatively unfamiliar phenomenon or technique the value of the illustrations therein can be judged on the basis of how well they present the conditions and complement the text

When the physician does not take the picture, he can make sure that the photographer knows what is required If possible the positioning and lighting of the subject should be checked by the medical personnel before the exposure is made. The photographer can often suggest the most suitable photographic treatment when he has been shown just what information is to be imparted.

Fundamentally a medical photograph is a graphic aid for conveying information In order to reap the full benefits of its potentialities the user must understand both the function of visual aids and the special properties of photographs The reason is that the success of any presentation demands more than technically good photographs This can be readily appreciated by considering the teaching field for a moment Here, the success of the instruction hinges on a suitable development of the topic An inept story can be well illustrated, yet succeed only to mislead

A facile transfer of ideas does not automatically become the reward of merely using modern graphic aids The teacher must know exactly what subjects should be placed in front of the lens The photographer must know how to arrange and light the correct aspect of the subject. The true effectiveness of a medical photograph *as a graphic aid to spoken* or written material therefore will depend on the acumen of the educator and the skill with which the photographer has recorded the "story"

The functions of illustrations, such as the *photographs with which* we are primarily concerned here are to take the place of many words and to augment and clarify the remaining discussion Obviously it is necessary to decide the respective roles of pictures and words For instance, a presentation necessitating a large amount of description usually becomes "long drawn out" if words play the leading part efficiency could be increased by employing photographs to carry the burden of description On the other hand an illustration that does not add much information to what a reasonable number of words could provide is also inefficient Sometimes a photograph can be utilized to "repeat" data in a different way for emphasis When such reiteration is ineffective or unnecessary the illustration is only an ornament It is essential then to learn how to arrive at a judicious balance between the graphic

and the verbal in order to provide efficient discourses.

To crystallize the argument so far a well-known medical graphic aid can be called upon as a familiar reference—the simple, taken-for-granted temperature chart. Suppose a clinician had to present verbally the absolute and excursional data that the temperature chart in a case of undulant fever would show at a glance. What a cumbersome array of words would be needed! Even then, words alone would be relatively ineffective in generating an idea of the characteristic undulatory nature of the temperature curve that is a major feature of the disease. The chart quickly imparts a visual concept of these variations. Once this has been mentally assimilated, the words "characteristic undulations" have the full significance of a lesson well learned—they have been implemented by the chart, which is then no longer needed in every discussion.

In the absence of a graphic illustration, recourse to a "verbal picture" is often necessary. For example the temperature curve as drawn on the chart might be likened to the silhouette of the Grand Tetons, but this would not be too helpful to the listener who did not know the Teton mountain range. However, through a series of such references to previously acquired visual experiences (universally familiar serrations in this case) words alone could be used to convey a fairly accurate concept.

Good judgment demands that photographs not be utilized to illustrate unimportant, too obvious, or irrelevant points. The significance of this can be readily seen by returning to our analogy. Obviously the utilization of the temperature chart as a graphic supplement could be superfluous on the following occasions: In a discussion limited to the splenic changes associated with undulant fever (unimportant); in discussing therapy and dosage intervals with a professional equal rather than a student (too obvious); or in a paper on the public health aspects (irrelevant).

The photograph, like any graphic aid, does not have unlimited powers of instruction. It can seldom "stand alone"; a complement of words and sometimes supplementary illustrations are needed. It would be academically dangerous to present a student with a series of temperature charts for the different types of undulant fever and not thoroughly discuss and draw attention to the fine points of similarity and difference. Also, sessions devoted to tropical medicine call for additional demonstrations of the characteristic curves in kala azar, malaria, and other undulatory diseases.

The object of any presentation is the communication of experience by those with the greater knowledge to those with the lesser knowledge. Since contact with reality is such an important phase of experience, a photograph has special properties as a graphic aid because of its realism—its potential fidelity of detail and accepted authenticity. For example, the very tangible stages of plastic surgery can be

Then all he has to do is to momentarily imagine himself presenting the illustration in the way intended This automatically almost ensures the full story telling content

A critical faculty regarding one's own work can be developed through making a careful study of the work of others Perhaps the best way to induce a self-critical frame of mind in this connection is to examine occasionally another's article dealing *with a relatively unfamiliar phenomenon* or technique the value of the illustrations therein can be judged on the basis of how well they present the conditions and complement the text.

When the physician does not take the picture he can make sure that the photographer knows what is required If possible, the positioning and lighting of the subject should be checked by the medical personnel *before the exposure is made* The photographer can often suggest the most suitable photographic treatment when he has been shown just what information is to be imparted.

Fundamentally a medical photograph is a graphic aid for conveying information In order to reap the full benefits of its potentialities the user must understand both the function of visual aids and the special *properties of photographs* The reason is that the success of any presentation demands more than technically good photographs This can be readily appreciated by considering the teaching field for a *moment* *Here* the success of the instruction hinges on a suitable development of *the topic An inept story can be well illu*strated, yet succeed only to mislead

A facile transfer of ideas does not automatically become the reward of merely using modern graphic aids The teacher *must know exactly what subjects should* be placed in front of the lens. The photographer must know how to arrange and light the correct aspect of the subject The true effectiveness of a medical photograph *as a graphic aid to spoken or written ma*terial, therefore, will depend on the acumen of the educator and the skill with which the photographer has recorded the "story"

The functions of illustrations such as the *photographs with which we are primarily* concerned here are to take the place of many words and to augment and clarify the remaining discussion Obviously it is necessary to decide the respective roles of *pictures and words For instance a pre*sentation necessitating a large amount of description usually becomes "long drawn out" if words play the leading part efficiency could be increased by employing photographs to carry the burden of description On the other hand an illustration that does not add much information to what a reasonable number of words could provide is also inefficient Sometimes a photograph can be utilized to "repeat" data in a different way for emphasis When such reiteration is ineffective or unnecessary the *illustration is only an ornament* It is essential then to learn how to arrive at a judicious balance between the graphic

patient. Medicolegal safeguards are also involved here. Photography can also preserve the fruits of many hours of careful work long after the treatment, surgery or experiment has been terminated and the condition has been remedied.

In addition to the intellectual aspect of photographs, the emotional impact often has to be considered. This is particularly true in providing human interest for institutional reports and press releases in the field of public relations.

Quality

The question that most often arises in the minds of physicians and technicians who are eager to start a photographic program is: How elaborate does the equipment have to be and how much experience is needed? Figure 1 illustrates the first part. The photograph on the left was made with a camera costing less than $10 by a 9-year old boy who had never before handled a camera. He was given less than 1 minute of instruction. The one on the right was made with a camera costing over $200 by an experienced medical photographer. The lighting for the second record was purposely made the same as the built in photo-flash system of the inexpensive camera and does not represent optimum lighting for the subject.

The young photographer could not have handled the second camera. On the other hand, the medical photographer could not have made a better picture with the first camera, but he would be competent to establish optimum lighting for use with the second camera. What then, is the advantage of precision cameras and photographic skill to weigh against the ease of using a simple camera?

Obviously a camera with a built in flash does not lend itself to versatility in lighting, yet there are numerous instances when this is not needed for clarity. Again, the negatives or color slides made in the inexpensive camera cannot be enlarged to the same extent as those made with the high-quality lens, nor can they provide large journal illustrations of the highest quality especially in color. But some times, the rendition of fine detail is not necessary. Thus, the whole question of quality hinges on the requirements. There are many subjects that cannot be handled without precise cameras and a background of photographic experience.

Figure 2 will help the individual to decide on his particular needs so that a photographic program can be planned efficiently.

In the center is an optimum record for showing the slight chest and hip malformations of the patient. It was made by an experienced medical photographer with professional camera and electronic flash lights such as those found in a medical photographic department. Expert lighting (see Chapter VI) was definitely needed for clearly depicting the condition. The great majority of subjects would not need

most convincingly illustrated with photographs because the viewer accepts the illustrations literally And he does not have to pause mentally to orient himself with respect to reality Photographs of course are only one type of graphic aid Charts drawings, schematic models and other nonphotographic aids are often selected when general conditions or probable relations are dealt with when a wealth of "photographic" detail might be confusing or when the viewer might unguardedly gain from photographs an impression of relations that actually do not exist It should not be overlooked that patients can serve as visual aids and that moulages can be quite realistic The teacher will have to decide which aid is best or expedient The quickness and readiness of photography is sometimes the deciding factor

In the previous discussions the examples have been drawn largely from the teaching field because the need for graphic aids there is obvious and long accorded. However the considerations for effectiveness and efficiency apply in other fields as well The reason is that fundamentally all medical photographs are made for instruction A person making (or ordering) a photograph does so either for imparting information to others or for his own information Both the research worker and the clinician in private practice can use photography for "taking notes" The skills and qualities discussed for the teaching aids proper are needed in such applications too this will be apparent to anyone who has struggled to interpret his pencil notes a year after they were made

In the academic field illustrations are universally recognized as necessities. This is true whether the "teaching" takes the form of classroom medical or paramedical instruction, professional lecturing, exhibiting, or publishing Photography is indispensable for many classroom sessions or professional clinics because it is obviously impracticable to rely on the availability of actual patients as "visual aids" quickly and when needed.

Furthermore photographs are valuable even in those fortuitous cases where patients *are* available, because the brief examination permitted a student will accomplish more if he has previously been *familiarized with the disease through photographs* He will observe significant details more closely and learn more thoroughly

In research photography serves to take "instantaneous" notes of observable conditions for lengthy study and for documentation Some times it can also record the invisible such as the loci of subcutaneous veins as well as movements and changes too fast, too slow or too complex for the eye to follow *It can thus aid materially* in diagnosis And in treatment too because slow improvements are often difficult to recognize when the patient load is heavy Serial photographs, however can guide the physician and encourage the

patient. Medicolegal safeguards are also involved here. Photography can also preserve the fruits of many hours of careful work long after the treatment, surgery or experiment has been terminated and the condition has been remedied.

In addition to the intellectual aspect of photographs, the emotional impact often has to be considered. This is particularly true in providing human interest for institutional reports and press releases in the field of public relations.

Quality

The question that most often arises in the minds of physicians and technicians who are eager to start a photographic program is How elaborate does the equipment have to be and how much experience is needed? Figure 1 illustrates the first part. The photograph on the left was made with a camera costing less than $10 by a 9-year old boy who had never before handled a camera. He was given less than 1 minute of instruction. The one on the right was made with a camera costing over $200 by an experienced medical photographer The lighting for the second record was purposely made the same as the built in photo-flash system of the inexpensive camera and does not represent optimum lighting for the subject.

The young photographer could not have handled the second camera. On the other hand, the medical photographer could not have made a better picture with the first camera, but he would be competent to establish optimum lighting for use with the second camera. What then, is the advantage of precision cameras and photographic skill to weigh against the ease of using a simple camera?

Obviously a camera with a built in flash does not lend itself to versatility in lighting, yet there are numerous instances when this is not needed for clarity Again, the negatives or color slides made in the inexpensive camera cannot be enlarged to the same extent as those made with the high-quality lens, nor can they provide large journal illustrations of the highest quality especially in color But some times, the rendition of fine detail is not necessary Thus, the whole question of quality hinges on the requirements There are many subjects that cannot be handled without precise cameras and a background of photographic experience

Figure 2 will help the individual to decide on his particular needs so that a photographic program can be planned efficiently

In the center is an optimum record for showing the slight chest and hip malformations of the patient. It was made by an experienced medical photographer with professional camera and electronic flash lights such as those found in a medical photographic department. Expert lighting (see Chapter VI) was definitely needed for clearly depicting the condition The great majority of subjects would not need

most convincingly illustrated with photographs because the viewer accepts the illustrations literally And he does not have to pause mentally to orient himself with respect to reality Photographs of course, are only one type of graphic aid Charts drawings schematic models and other nonphotographic aids are often selected when general conditions or probable relations are dealt with, when a wealth of "photographic" detail might be confusing, or when the viewer might unguardedly gain from photographs an impression of relations that actually do not exist It should not be overlooked that patients can serve as visual aids and that moulages can be quite realistic The teacher will have to decide which aid is best or expedient The quickness and readiness of photography is sometimes the deciding factor

In the previous discussions the examples have been drawn largely from the teaching field because the need for graphic aids there is obvious and long accorded However the considerations for effectiveness and efficiency apply in other fields as well The reason is that fundamentally all medical photographs are made for instruction A person making (or ordering) a photograph does so either for imparting information to others or for his own information Both the research worker and the clinician in private practice can use photography for "taking notes" The skills and qualities discussed for the teaching aids proper are needed in such applications too this will be apparent to anyone who has struggled to interpret his pencil notes a year after they were made

In the academic field illustrations are universally recognized as necessities This is true whether the "teaching" takes the form of classroom medical or paramedical instruction professional lecturing, exhibiting, or publishing Photography is indispensable for many classroom sessions or professional clinics, because it is obviously impracticable to rely on the availability of actual patients as "visual aids" quickly and when needed

Furthermore, photographs are valuable even in those fortuitous cases where patients *are* available because the brief examination permitted a student will accomplish more if he has previously been familiarized with the disease through photographs He will observe significant details more closely and learn more thoroughly

In research, photography serves to take "instantaneous" notes of observable conditions for lengthy study and for documentation Some times it can also record the invisible such as the loci of subcutaneous veins, as well as movements and changes too fast, too slow or too complex for the eye to follow It can thus aid materially in diagnosis. And in treatment too because slow improvements are often difficult to recognize when the patient load is heavy Serial photographs however can guide the physician and encourage the

The simple technique is capable of providing excellent results with the majority of subjects, and the optimum in many. Quite often some extra thought given to positioning is helpful. For example, the record on the right shows the figure turned somewhat—the frontal view was not so revealing. This record was adequate for the personal notes of the physician, who was interested in the thoracic condition. But it would be valueless as a teaching illustration, because the morphologic aspects are not clearly enough delineated.

Figure 3 depicts the essence of the simple system. A miniature roll-film camera is utilized so that no darkroom is needed for loading. The films, whether black-and-white or color, can be efficiently processed by a competent photofinisher. Lighting is accomplished with photoflash or electronic flash lamps. The work can be quickly done in the office and there is no need to darken the room, although the flash will not predominate when direct sunlight falls on the patient.

A long window shade mounted on the ceiling can be pulled down to provide a background for full- or half-length shots. It is usually not needed for close-ups. The maximum clear space required between camera and patient is about 9 feet. The details of this simple system are given in Chapter III.

The general discussions in this book apply to all three methods of working. Specific references will be obvious if the three distinctions are kept in mind. Thus the reader will be able to obtain the information that pertains to the program which suits his requirements. It is suggested that items of special interest be lightly checked off in the index or contents heading the first time any section is read.

Showing the Lens

The prime concerns of many photographers are lens aperture, shutter speeds, focusing scales, and darkroom procedures. These are the technical aspects of photography. With a little practice they become automatic and the photographer should train himself to relegate such details to the motor regions of his brain. The "creative section" of his mind can then be free to attend to the first major consideration—that of *showing the lens what is expected* in the photograph. This is the most important factor in a good photograph and warrants discussion.

When a physician is confronted with, let us say, an interesting skin lesion, he can examine it from many angles. He can look at it closely or at a distance. He can take the patient to a window or throw a light on the lesion. He gathers perspective and also three dimensions because he has two eyes. Gradually he builds up a mental impression of the lesion. This image in his mind becomes so strong that it overlays any visual image that may be received from a momentary set of viewing conditions.

Figure 1-3: The simple system in action for a close up record Patients of all ages can be quickly photographed in the office by this method Direct sunlight should not fall on the subject but apart from this there is no need to darken the room

The simple technique is capable of providing excellent results with the majority of subjects, and the optimum in many. Quite often some extra thought given to positioning is helpful. For example, the record on the right shows the figure turned somewhat—the frontal view was not so revealing. This record was adequate for the personal notes of the physician, who was interested in the thoracic condition. But it would be valueless as a teaching illustration, because the morphologic aspects are not clearly enough delineated.

Figure 3 depicts the essence of the simple system. A miniature roll-film camera is utilized so that no darkroom is needed for loading. The films, whether black-and-white or color can be efficiently processed by a competent photofinisher. Lighting is accomplished with photoflash or electronic flash lamps. The work can be quickly done in the office and there is no need to darken the room, although the flash will not predominate when direct sunlight falls on the patient.

A long window shade mounted on the ceiling, can be pulled down to provide a background for full—or half length shots, it is usually not needed for close-ups. The maximum clear space required between camera and patient is about 8 feet. The details of this simple system are given in Chapter III.

The general discussions in this book apply to all three methods of working. Specific references will be obvious if the three distinctions are kept in mind. Thus the reader will be able to obtain the information that pertains to the program which suits his requirements. It is suggested that items of special interest be lightly checked off in the index or contents heading the first time any section is read.

Showing the Lens

The prime concerns of many photographers are lens aperture, shutter speeds, focusing scales, and darkroom procedures. These are the technical aspects of photography. With a little practice they become automatic and the photographer should train himself to relegate such details to the motor regions of his brain. The "creative section" of his mind can then be free to attend to the first major consideration—that of *showing the lens what is expected* in the photograph. This is the most important factor in a good photograph and warrants discussion.

When a physician is confronted with, let us say, an interesting skin lesion, he can examine it from many angles. He can look at it closely or at a distance. He can take the patient to a window or throw a light on the lesion. He gathers perspective and also three dimensions because he has two eyes. Gradually he builds up a mental impression of the lesion. This image in his mind becomes so strong that it overlays any visual image that may be received from a momentary set of viewing conditions.

Figure I-3: The simple system in action for a close-up record Patients of *all ages can be quickly photographed in the office by this method Direct* sunlight should not fall on the subject but apart from this there is no need to darken the room

the data. Rather the book should be looked upon as a reference for "brushing up" on various phases as the need arises.

The first technical detail for consideration will probably be the camera. The beginner should obtain one that seems to suit most of his needs. By working with it alone he can soon master it and this is a more satisfactory procedure than trying to use many cameras at the start. The space available for photography has some bearing on the camera chosen.

The selection of films and filters is another technical detail taken up in this book. Here again, one or two films should be adopted at the start. The fine points of

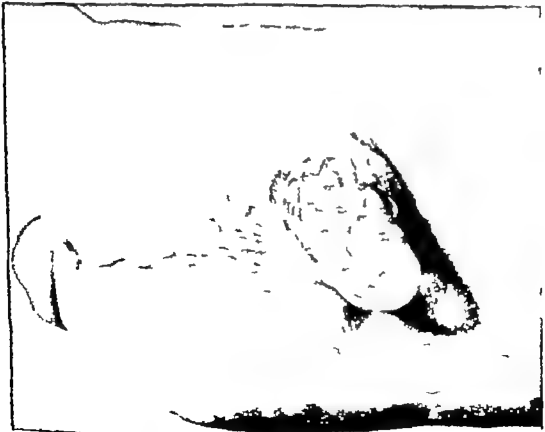


Figure 1-4 Meningocele; a subject requiring careful posing and lighting

The camera on the other hand, has only one "eye" It makes a picture from one viewpoint and under one lighting It is mandatory then that the subject be posed and lighted in a way to ensure that the lens "sees" what the photographer s mind sees The photographer must show the lens what is wanted, not just take what the lens might otherwise give him

This point is demonstrated in Figure 4 Here the sac had to be presented to the camera at the correct angle to show its curvature The buttocks were included in the field to indicate anatomical location The lighting had to be arranged to make the sac "stand out" in a horn like fashion rather than to appear to lie in contact with the infant s back The problem was further complicated from the fact that the shape of the sac and the transparency of the fluid combined to produce a crude lens which focused a spot of light into the shadow of the sac Such a spot helped to indicate the true character of the anomaly but it had to be located in a position that would not cause it to obliterate other features The result is such that the reader can now form a mental image similar to the one the original physician had when he asked for the photograph

It is not difficult to master this most important (though seldom stressed) aspect of medical photography The mechanical details of posing and lighting are discussed further on in this book The fundamental point to make here is as follows The photographer should examine his ground glass check in his view finder or place one of his eyes (with the other closed) at the camera lens position and note what the lens is being shown Does what the lens sees correspond as nearly as possible to the mental image? Just asking that question —before the shutter is operated—is one of the greatest steps in making a good medical photograph

In its first principle good photography is amazingly simple—when the subject is *seen* clearly it can be *photographed* clearly Thus the main skill in optimum photography lies in so positioning and lighting the subject that it can be seen clearly

Technical Details

The technical details of course *do* have to be mastered For the beginner the task often seems like a lifework However with a systematic study of basic theory and with careful practice it is surprising how soon studio "bug-a boos" and darkroom "pixies" can be dispelled—provided that they are not encouraged by a hopeless approach

The major portion of this book is devoted to the various technical aspects of medical photography It is not intended that the material be absorbed in one sitting The information is sectionalized so that various points can be studied, carried out and restudied There is no need to make a formidable task out of applying

CHAPTER II EQUIPMENT AND SPACE

SEVERAL pieces of equipment are required for medical photography and considerations are given in this chapter that will be helpful in selecting new items or in evaluating those on hand.

Cameras

In general, a view-type camera (see Figure 1)—that is, one with a ground-glass back, and possibly with interchangeable lenses, and a double-extension bellows—is the most useful camera for a photographic department or a clinic. It permits careful focusing and composing and can be readily used in close-up work. For the physician making records in the office, a miniature roll-film camera is often more convenient and simpler to use. (See Chapter III.)

Since so much work today is done with color film, another requirement is imposed on the camera. If the records desired are the 2 x 2-inch color slides, a miniature roll-film camera will be needed. When sheet color films are to be used for 3¼ x 4 inch lantern slides, a view-type camera is necessary. It should be remembered, however that 35-millimeter color duplicates can be obtained from sheet film transparencies. The 2¼ x 3¼ or 3¼ x 4¼-inch formats are most economical, since the transparencies do not have to be cut (and thus partially wasted) for binding. Larger sheet film cameras, accepting 4 x 5 or 5 x 7 inch films are often preferred when many black-and-white negatives are to be made. The larger transparencies, too, are better to use for exhibition purposes, although enlarged duplicates can be made from the smaller transparencies. If such a camera has a 3¼ x 4¼-inch reducing back or film-kit, it becomes practical to use it with color films for 3¼ x 4-inch lantern slides.

Color negative films lead to color prints slides and transparencies and also black and-white prints. Hence they should be considered when selecting a versatile camera.

The lens chosen should be an anastigmat of good quality. For the ultimate in color photography it should be corrected for

film usage can be studied later The same remarks apply to developers and other darkroom solutions

The respective advantages of photoflash and photoflood lighting systems will have to be studied Then equipment and methods to suit individual requirements can be adopted The beginner should use standard lighting plans During the transition from the utilization of such a system to the application of special lightings for each case, he can make one exposure with the standard setup and then follow this with experimental lightings for comparison His goal should be the best possible lighting for each subject and this can be arrived at through experimentation and practice It is obviously unwise to experiment and run the risk of a failure without first ensuring the good record that is obtainable from a standard lighting setup

The final technical phase is making prints Contact printers and enlargers are easy to use Nevertheless there are several factors to take into account in obtaining prints of excellent quality Here again, the beginner should learn to use a few papers well before diversifying his technique Equipment and procedures are discussed

Clinical infrared photography has special and valuable applications It demands a careful but not difficult technique Ways to obtain optimum results are presented in the last chapter

There is one feature on present-day shutters that is particularly valuable in this field. It is the built-in synchronization mechanism. Flash photography has advantages to be outlined in the chapters on Posing and Lighting. Therefore a reliable synchronized shutter is an asset. A "blade-arrester" on many view cameras, is also a great convenience since it permits making the exposure quickly after focusing. This mechanism includes a button at the shutter rim. With it the shutter can be set at the desired speed, say 1/50 second, and the blades held open for the focusing. Recocking the shutter sets the shutter for the exposure. This is more efficient than setting the shutter at "T" during focusing and then changing to 1/50 for the exposure.

Exposure Meters

An exposure meter of the photoelectric type is of considerable help when individual lightings are adopted for each subject. It is true that exposure tables provide the necessary data for standard setups. However, these are mainly a basis for operation. With the optimum lighting needed for many medical subjects an exposure meter offers a chance to speed up photography. They are simple to use and remove many mental hazards in carrying out the technical phases of medical photography. They do not automatically guarantee good exposures, but serve as a guide to trials in working out a technique.

Lights

When considering the lighting equipment necessary for photography of patients, it can readily be appreciated that the lighting units should be compact and easy to handle, that the lamps should be efficient, and that some means of temporarily lessening the intensity of the light while posing the patient is advisable.

In general the "flood" type of photographic stand-light is most suitable. Four lamp units are needed for the full-length photography of patients. The spotlight is a useful accessory since it provides a "raw" light for recording fine textures in many lesions. The "clamp-on" type of light has application in the wards and in other locations away from the studio or regular photographic quarters.

Photoflood or 3200°K lamps are used in this type of light. They are most economical and permit careful study of the lighting. When used with dimmers to reduce heat, they offer reasonable comfort to the patient. They call for the use of fast films when possible in order to keep exposures to a minimum time.

Electronic flash units are highly satisfactory. Their flash is so rapid that worries about camera and subject movement can be forgotten. They are particularly valuable with restless children and fidgety adults. They present no heat problems. They can be used with black-and-white and daylight color films. Professional

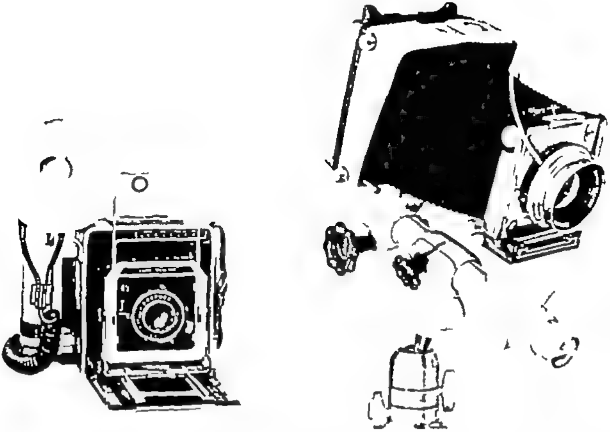


Figure II 1: *A* the 4 x 5 Super Graphic press type camera useful in the studio wards and other locations *B* the Linhof-Color 4 x 5 View Camera These represent the types of camera that are most useful in medical photographic departments The requirements of a view camera are a long bellows a ground-glass focusing back interchangeable lenses independent front and back movements and swings and a sturdy construction *(Illustrations courtesy of Graflex Incorporated Rochester N Y., and Linhof Corporation of America Kling Photo Corporation 257 Fourth Avenue New York, N Y)*

both lateral and longitudinal chromatic aberrations It is also very desirable to utilize a coated lens in color work, since it provides the purest rendition of colors. The maximum aperture need not be great, although an f/4.5 lens is usually desirable should the camera be required for other purposes Nevertheless most medical photography is done at an aperture of f/8 or smaller so that f/8 anastigmat lens of top quality is entirely practical and more economical.

Most good lenses are equipped with shutters that are suitable for medical work.

seconds output each are required and will energize four lamps together (Smaller units, including ringlights, are described in Chapter III.)

Electronic flash lights with modeling lamps incorporated are necessary They are small tungsten bulbs contained in the reflector units with the flash tubes. They permit studying the effects of lighting so that the same results are obtained with the flash. With such advantages, these units can well comprise the chief lighting equipment, especially when a new photographic department is planned.

In situations where photography is not a steady daily routine it may be more practical to consider photoflash equipment. Stand lights are available with extension cords (Figure 2) or with slave units for firing the bulbs from the flash of the bulb that is fired by the camera shutter The latter are the handiest. Photoflash lamps offer the advantage of fast shutter speeds to minimize movement, they do not subject the patient to heat during positioning. Bulbs are relatively inexpensive when small quantities are used, though not as economical as photoflood lamps.

They are most useful in standardized and simple setups. For optimum lighting, supplementary flood lights (of low power and heat) can be temporarily located for studying lighting effects. The photoflash units are then put in the same positions for making the exposure Thus the procedure is somewhat time consuming and mainly practical when optimum photography is not often required.

Lamps

No. 1 or 2 photofloods yield illumination of the correct color quality for miniature indoor color films. They are also desirable for black-and white work, because the light output allows relatively short exposures at small apertures. The No. 2 photoflood lamps are most practical for black and-white and miniature color work in medical photography since they have a relatively long rated life Professional Color Films of the indoor type require illumination with a color temperature of 3200 Kelvin the 500-watt, PS-25 3200 K Mazda Lamp is suggested. It is also suitable for making black-and-white negatives.

The most useful photoflash lamps are the General Electric and Westinghouse numbers 22, M5 and 5 or the Sylvania (Wabash) 2 and 25 These can be fired in synchronizers or quite often by the open-flash method. In the latter instance the camera shutter is opened (with dim room light) the bulbs are fired, and the shutter closed. Exposure data for these lamps are given in Chapter VII.

Dimmers

A valuable accessory for use in medical photography is a dimmer Such a device permits lamps to be dimmed for focusing

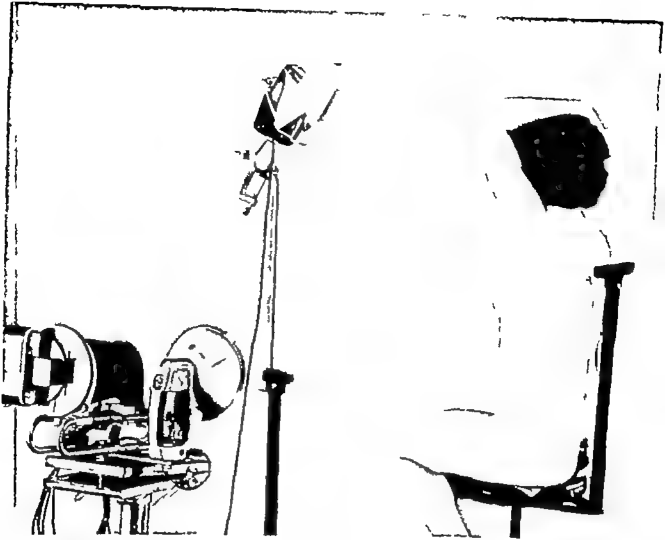


Figure II 2 Photoflash lighting setup A fill in lamp is on the camera while a separate unit with a stronger bulb provides modeling Such units can be fired by means of extension cords or by slaves actuated through photocells Further details on lighting are given in Chapter VI

lamps are available for the photographic department. For the clinic or the office space large enough for an optimum setup (see page 27) there are home portraiture models that are more compact and fully useful in medical applications They should be used in conjunction with the large professional power packs, however so that sufficient illumination can be provided Two of these latter having about 550 watt

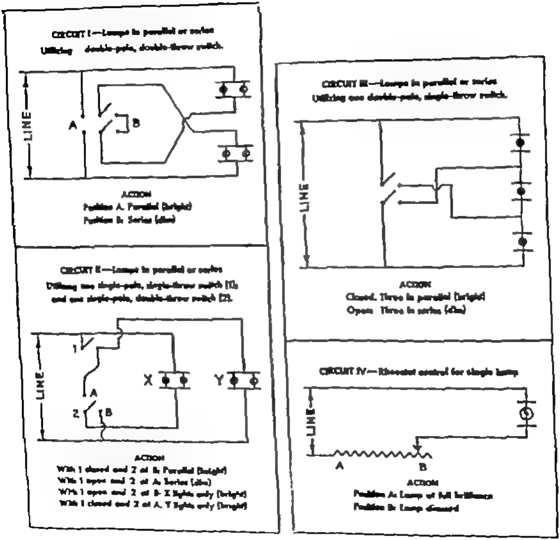


Figure II-3 Dimmer circuits for photoflood lamps.

and composing procedures and to be lighted at full brilliance for making the ex posure Its employment offers the follow ing advantages In the photography of a patient, it contributes to his comfort because he is not subjected to the heat from fully lighted lamps except for a brief interval at the time of the exposure Too the dimmer conserves lamps—thus effect ing a saving—because the life of each lamp is lengthened considerably if it is lighted at full brilliance only during the exposures A dimmer also offers a convenient outlet box for firing several photoflash lamps in an open flash technique It should be con nected to a dry battery for bulbs not fused for 110 volts

It is usually best to have a competent electrician construct a dimmer since safety codes must be observed Because the information is difficult to obtain elsewhere the construction of dimmers is dealt with fully here. The accompanying diagrams Figure 3 indicate the required switches and other equipment and also show methods of wiring them Some stand lights have dimmer switches incorporated in their design

SERIES PARALLEL CIRCUITS A series-parallel circuit is one in which two or more lamps, or similar banks of lamps, can be so operated that the line voltage is either impressed in full across each lamp (parallel) or is divided equally among the lamps (series) In circuits of this type the lamps burn at full brilliance when operated in parallel and are dimmed when operated in series

Circuits I and II are of the two-branch type and the diagrams are based on the employment of four lamps. The circuits can accommodate fewer or more lamps, of course but it should be remembered that the wattage consumed by each branch of a series parallel circuit should be the same. Hence, it is necessary to use an even number of lamps of the same wattage (four No 1 photoflood lamps, for example) except when the lighting setup permits the use of such a combina tion as two No 1 photoflood lamps in series with a single No 2 photoflood lamp Occasionally a lighting technique needs three similar lamps—one on one side of the subject and two on the other In order to utilize a two-branch, series parallel circuit under these circum stances, the single lamp can be aug mented with another and the lamp-to-subject distance for this pair fixed at 1 4 times the distance specified for the single lamp This procedure makes al lowance for the increased brilliance resulting from adding the fourth lamp

The most convenient method of providing two-branch, series parallel switching is to employ a double-pole, double throw switch Circuit I indicates the required wiring When the switch utilized is of the "knife" type, an adequate in sulated protective housing should be provided. If a rotary double-pole, double-throw switch with high, medium, low

When alternating current is available it is possible to utilize a variable autotransformer instead of a resistance with single lamps. The required wiring is quite similar to that for a rheostat. Such an alternative is not an economical one but it is worth considering if an autotransformer should happen to be more readily available than a rheostat. It is not practical for dimming a bank of lamps.

Another method of dimming a single lamp is to use a series-parallel circuit in conjunction with another similar lamp. The second light is turned toward the wall, where it does not shine on the subject. This method is practical only for occasional usage since the second lamp is consumed without providing illumination.

Camera Supports

With view-type cameras a tripod or other support for the camera is necessary; with roll-film cameras it is optional, although a support adds to the ease with which accurately composed photographs can be made. The tripod for medical photography should have a center post that can be elevated independently of the legs. This makes for maximum speed and convenience when locating the camera at the desired height for each patient or area of interest. When the legs cannot be locked a brace should be provided to prevent them from slipping apart.

A specially high tripod or camera stand is required for photographing patients in bed in the wards. An alternative is a small table upon which a small tripod can be placed. It is practical to have such a table sturdy enough to provide a platform for the photographer too. In Chapter V a means for obviating the need for a high tripod with patients on carts is described.

A discarded x-ray stand can be readily converted into a handy camera support. To do this it is merely necessary to insert a steel plate into the tube-holding mechanism. The plate should have felt cemeted to its camera side and, of course, have a hole for the tripod screw.

Backgrounds

A plain background is essential to minimize distracting extraneous details in the picture. Provided the subject is clearly depicted, there is nothing more that detracts from a photograph than a messy background, see Figure 4. Shiny blobs from out-of-focus instruments, laboratory details, desks, diplomas on walls, waste baskets, and numerous other items may lend "local color" but medical photographs are essentially close-ups and don't need it!

It is often possible to utilize the wall of a room or the end of a passageway as a background. However, a portable background can be made from a sheet of wallboard. A piece 5½ x 7 feet is suitable and convenient for any view up to a full-length study. One side can be painted light gray and the other black. Such a background should be supported by sturdy feet or by

and off positions (such as one from a discarded electrical heater) is available, it will answer the purpose.

A second form of two-branch circuit is shown as Circuit II, which utilizes a single-pole, single-throw switch — the ordinary "on-off" type—and a single-pole double-throw switch—the ordinary "three-way" type.

It is also practical to utilize a three-branch, series parallel circuit for three lamps of the same wattage. When three photoflood lamps are dimmed by this means (that is, operated in series) they yield less dimmed light than two equivalent lamps similarly operated however they provide sufficient illumination for most preliminary photographic procedures The three-branch circuit has the inherent advantage of conserving the life of the lamps to a greater extent than a two-branch circuit and, of course, is the logical setup for lighting arrangements that call for three similar lamps. Circuit III shows the required wiring and switch —the ordinary double-pole or two-circuit, "on-off" type

For maximum convenience in operation the mechanical construction of any of these circuits requires the use of a suitable electrical outlet box into which can be assembled the lead in cable, switches and outlets for the lamps Provision for operating the switches with the foot is often convenient because the hands are then left free.

The wires in the unit should be heavy enough to carry the electrical load of the separate branches, and the lead in cable should be capable of sustaining the combined load of all the lamps when they are lighted at full brilliance

Since the current for all of the lamps will be supplied from a single wall outlet, it is necessary to make sure that wiring and fusing to the outlet are adequate. Another precaution is necessary when a dimmer is utilized — the plug on the lead in cable should never be pulled out of the wall outlet while the lamps are lighted otherwise, dangerous arcing may occur Lamps should first be turned off at the unit or at each socket

DIMMING SINGLE LAMPS OR BANKS When all of the illumination must be provided by a single lamp (as, for example, in some types of close-up photography) or from the single bank present in some departments, a series parallel arrangement is obviously impracticable. The lamps can, however be dimmed by means of a fixed resistor or a rheostat (gradual dimming) connected in series with them Some professional studio lights have a resistor built into the stand A rheostat chosen for the purpose should be capable of carrying the same current as that drawn by the lamp or bank Its maximum resistance should at least be equivalent to that of the lamp load, but it can be greater By setting the rheostat so that a resistance equivalent to that of the lamps is included in the circuit, the lamps are dimmed to the same extent that they would be if another similar lamp or bank were placed in series Circuit IV shows the necessary wiring for incorporating a rheostat.

tracks, one behind the other enable the photographer to select the one he wants. Drapes, of course, can be easily drawn around a corner to a side wall when not in use. This can also be done with panels when they are suspended at the two upper corners only and such an expedient is useful in relatively small studios.

In a regular photographic department a continuous built in background is feasible. The floor and wall should be about the same tone: this can be accomplished by using the same paint on both. The base board should be omitted and a cove substituted. Paneling should be omitted from the wall. If there is a likelihood of traffic over the patient area, which would mar the paint unduly a low platform can be

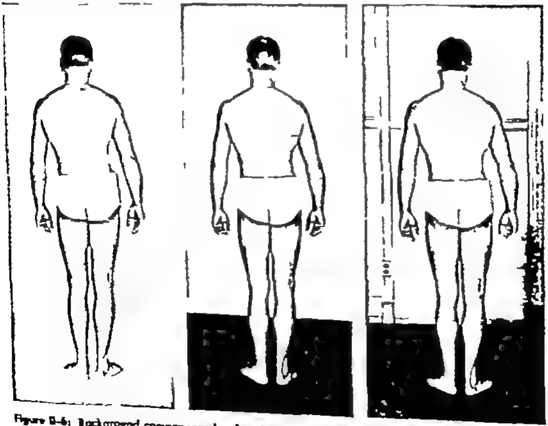


Figure II-6: Background comparison showing the results obtainable with a continuous background from floor to ceiling and with the usual discontinuous floor and wall backgrounds.

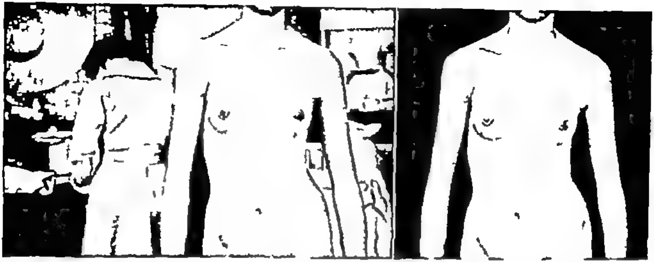


Figure II-4: The laboratory sink is not present in *A* but practically everything else is Such distracting background details should be avoided so that full attention can be paid to the subject A simple grey background curtain was used for *B* and this makes the great deal of difference in clarity between the two records (apart from judicious trimming) *A* and *B* were photographed from the same camera viewpoint and with the same lighting

wall cleats (The room itself should be finished in a light color this is especially important for color photography for which a light gray is best, because other colors would reflect light that might affect the color rendering of the subject)

The following types of background are also worthy of consideration for the office

Sliding drapes fitted on rods over a door way (gray monk s cloth would be suitable for a light background and black velveteen, for a dark one)

Cloth (such as gray surgical sheeting) supported on a rod that can be placed on hooks in a wall.

Roller window shades of adequate size, suspended from the ceiling

While most pictures can well be taken against a light background there are two particular advantages of a black background. Some types of anatomic and posture work require fiducial lines or grids on the print. Since a black background yields little or no density in the negative, it is easy to introduce lines when a background of this nature is used Again, for studies of limitation of movement, made by double or multiple exposures it is essential that the background remain clear in the negative. In this way successive images of the limb are not marred with background detail or density

Composition board panels about 7 feet wide or plain drapes can be hung on hospital tracks in a large department Several

tracks, one behind the other enable the photographer to select the one he wants. Drapes, of course can be easily drawn around a corner to a side wall when not in use This can also be done with panels when they are suspended at the two upper corners only and such an expedient is useful in relatively small studios.

In a regular photographic department a continuous built in background is feasible The floor and wall should be about the same tone- this can be accomplished by using the same paint on both. The base board should be omitted and a cove substituted. Paneling should be omitted from the wall. If there is a likelihood of traffic over the patient area, which would mar the paint unduly a low platform can be

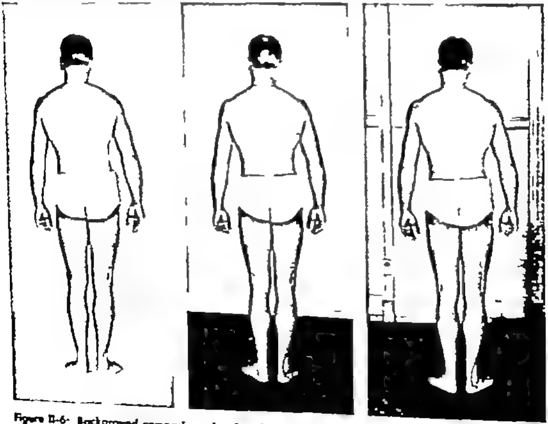


Figure II-6- Background comparison showing the results obtainable with a continuous background from floor to ceiling and with the usual discontinuous floor and wall backgrounds.

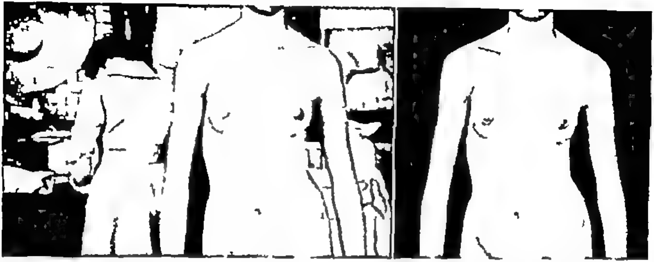


Figure II-4: The laboratory sink is not present in *A* but practically everything else is Such dis tracting background details should be avoided so that full attention can be paid to the subject A simple grey background curtain was used for *B* and this makes the great deal of difference in clarity between the two records (apart from judicious trimming) *A* and *B* were photographed from the same camera viewpoint and with the same lighting

wall cleats (The room itself should be finished in a light color this is especially important for color photography for which a light gray is best, because other colors would reflect light that might affect the color rendering of the subject.)

The following types of background are also worthy of consideration for the office

- *Sliding drapes* fitted on rods over a door way (gray monk s cloth would be suit able for a light background and black velveteen, for a dark one)
- *Cloth* (such as gray surgical sheeting) supported on a rod that can be placed on hooks in a wall.
- *Roller window shades* of adequate size, suspended from the ceiling

While most pictures can well be taken against a light background, there are two particular advantages of a black back ground Some types of anatomic and pos ture work require fiducial lines or grids on the print Since a black background yields little or no density in the negative it is easy to introduce lines when a background of this nature is used Again for studies of limitation of movement made by double or multiple exposures, it is essential that the background remain clear in the neg ative In this way successive images of the limb are not marred with background de- tail or density

Composition board panels about 7 feet wide or plain drapes can be hung on hos pital tracks in a large department. Several

tracks, one behind the other enable the photographer to select the one he wants. Drapes, of course can be easily drawn around a corner to a side wall when not in use This can also be done with panels when they are suspended at the two upper corners only and such an expedient is useful in relatively small studios.

In a regular photographic department a continuous built in background is feasible The floor and wall should be about the same tone this can be accomplished by using the same paint on both. The base board should be omitted and a cove substituted. Paneling should be omitted from the wall. If there is a likelihood of traffic over the patient area, which would mar the paint unduly a low platform can be

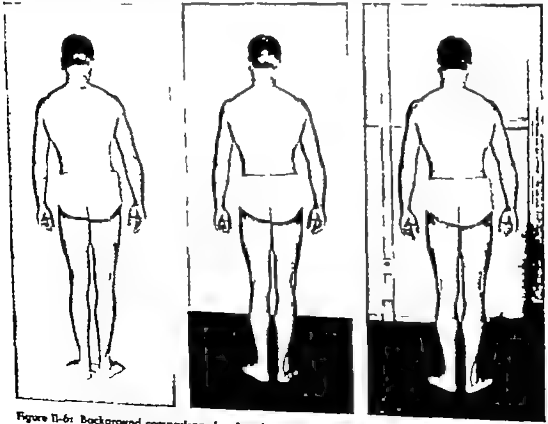


Figure II-6: Background comparison showing the results obtainable with a continuous background from floor to ceiling and with the usual discontinuous floor and wall backgrounds.

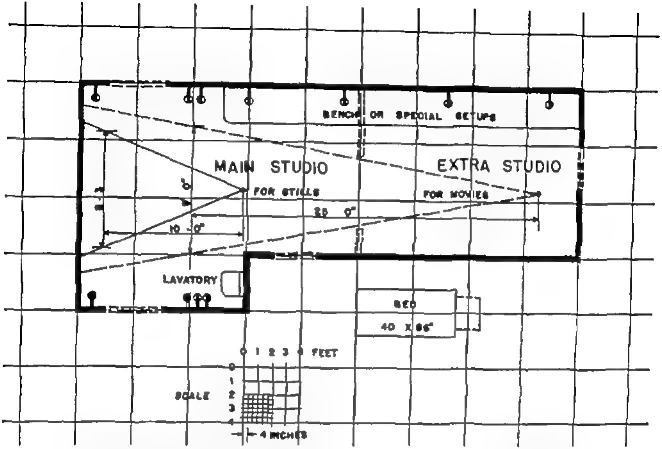


Figure II-7: Floor area of a studio suitable for photographing patients; note 'T' shape. Indents at sides can be used for benches or setups for photographing eyes, mouth, and so forth, within the studio, or for other rooms. Feasible door locations are shown as dotted lines. The small figure represents a bed and attendant.

utilized. This could be constructed so that it can be raised and lowered on a piano hinge so as to save space.

The tone of such a continuous background should be about that of a dove gray. For color photography a pale aquamarine tint, diluted with white and gray, is often preferred; strong colors should be avoided because they tinge the image. (See Figure II-5, Plate II, page 29.) The density at which these photograph depends on the amount of light thrown on them. By lighting the patient brightly at about five feet from the wall and by directing the lights as little as possible toward the background, it is possible to make the latter record almost black. On the other hand, throwing sufficient light

on this background causes it to photograph white. Such a background should be about nine feet wide and the base should extend about six feet out from the wall. The benefits of a continuous background are shown in Figure 6.

Means for Immobilization

The production of a good medical photograph requires that the area of interest be kept in focus after the patient has been posed and that movement be prevented during the exposure. In close-up work particularly where the depth of field with any lens is always relatively shallow adequate immobilization is imperative, because the slightest degree of deviation from the position established before the exposure and movement during the exposure, are bound to cause a noticeable blurring of the image Practical immobilization can be attained if the patient is made comfortable during the photographic procedure accordingly a chair—preferably with a headrest—or a stool should be provided, or the office examining table should be adapted for support. A suitable stool and the use of a special device for eye photography are discussed in Chapter V

Space Requirements

The studio in an institution or clinic should have an unobstructed floor area of about 16 feet long for full-length patient photography It should be at least 12 feet wide at the background end to permit the placement of lights. Figure 7 shows a suitable space. It shows the camera field angles for both still and motion picture applications.

While full data on the layout of photographic departments are beyond the scope of this book (information can be obtained from photographic manufacturers) it will be valuable to present here a well planned small department Figure 8 shows such a layout and indicates how the area for patient photography can be related to other activities and to darkrooms.

When color films that are not processed by the photographer are utilized, there is no need for darkroom facilities It is, however desirable to provide a small closet for storing and loading sheet films. A space of about 4 x 5 feet is sufficient. The door should fit tightly to preclude light leaks.

Office Space

The amount and type of space required for making office records will depend on the method of working. When a miniature roll film camera is employed for making full length or half length photographs of patients the only space requirement is a sufficient unobstructed camera-subject distance The background wall should be uncluttered—if necessary a medium-toned window shade, four or five feet wide, can be mounted for pulling down behind the patient. There will be no darkroom needed for loading films in this method. Color films that are processed by the manufac

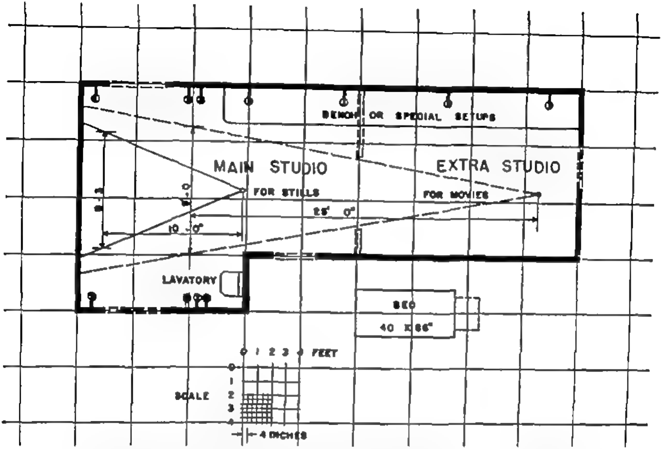


Figure II 7 Floor area of a studio suitable for photographing patients; note 'T' shape Indents at sides can be used for benches or setups for photographing eyes mouth and so forth within the studio or for other rooms Feasible door locations are shown as dotted lines The small figure represents a bed and attendant

utilized This could be constructed so that it can be raised and lowered on a piano hinge so as to save space

The tone of such a continuous back ground should be about that of a dove gray For color photography a pale aqua marine tint, diluted with white and gray is often preferred strong colors should be avoided because they tinge the image (See Figure II-5 Plate II page 29) The density at which these photograph depends on the amount of light thrown on them By lighting the patient brightly at about five feet from the wall and by directing the lights as little as possible toward the background, it is possible to make the latter record almost black On the other hand throwing sufficient light

turer and black-and-white roll films can be loaded in the light, so that a darkroom is only needed when the physician plans to make negatives and prints on the premises.

The average camera-subject distance for a full-length study with any standard camera is nine feet. When a smaller film than the one primarily intended for the camera is utilized, this distance is increased and has to be found by trial. The width of the office area need only be about four feet if a photoflash technique is adopted. However when stand lights are employed it is necessary to have space at the patient end of the area for the lights to be arranged. A clear square 7 x 7 feet in size would allow for lighting the full figure; the rest of the 9 or 10 feet for a camera throw need not be the full 7 feet wide.

A good way to save space when flood lighting is adopted is to attach lighting units to the walls semi-permanently. This provides a standard lighting that can give reasonably good results in the majority of cases. Four lights on each wall would offer a facility for unbalanced lighting with full figures when desired. Sometimes one wall is closer to the patient than the other. Then No. 2 photoflood lamps can be placed at the farther wall and No. 1 lamps on the nearer. (When a No. 2 lamp is at 1.4 times the distance of a No. 1 their intensities are practically equal.) Adopting fixed lighting like this not only saves space and lighting time but also gives standard intensities, thereby simplifying exposure determinations.

A small closet near by the patient end of the room is desirable for stowing away stand lamps, fully set up. This saves a lot of time in getting ready for a photograph. Camera and film can be stored in a desk or cabinet at the other end of the room.

In employing a view-type camera with a ground-glass focusing back, the same considerations as in the foregoing apply. However there is the additional need for a tripod with these cameras and this entails about two feet more space for making full-length records. A place to store the camera on the tripod would save the time required for setting them up.

Film packs are available for making black-and-white negatives with most view-type cameras. These can be loaded in the light; sheet films for special purposes would have to be loaded in a darkroom, and color films too. A lighttight closet about 30 x 48 inches would suffice as a loading room in the event that a processing darkroom not be considered. The physician not confining his work to making exposures only would have to arrange space for a processing darkroom. Facilities for both negatives and prints would have to be provided.

Darkroom Items

The selection of darkroom equipment will depend upon the amount and type of work done. There are no special require-

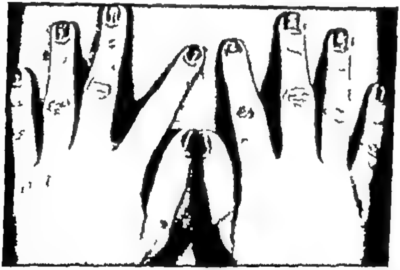


Figure III-5: Top Since the lamp is very close to the lens axis on the Startech Camera good illumination is provided for closeups of cavities Bottom A field of 9 x 13¼-inches was obtained with a 1+ supplementary lens an improvised focal frame and a flashholder on a 35 millimeter camera Such illumination would not be suitable for cavities but a ringlight could be employed for both the purposes.

Plate III

turer and black-and-white roll-films can be loaded in the light, so that a darkroom is only needed when the physician plans to make negatives and prints on the premises.

The average camera-subject distance for a full-length study with any standard camera is nine feet. When a smaller film than the one primarily intended for the camera is utilized, this distance is increased and has to be found by trial. The width of the office area need only be about four feet if a photoflash technique is adopted. However when stand lights are employed it is necessary to have space at the patient end of the area for the lights to be arranged. A clear square 7 x 7 feet in size would allow for lighting the full figure- the rest of the 9 or 10 feet for a camera throw need not be the full 7 feet wide

A good way to save space when flood lighting is adopted is to attach lighting units to the walls semi-permanently This provides a standard lighting that can give reasonably good results in the majority of cases. Four lights on each wall would offer a facility for unbalanced lighting with full figures when desired Sometimes one wall is closer to the patient than the other Then No. 2 photoflood lamps can be placed at the farther wall and No. 1 lamps on the nearer (When a No. 2 lamp is at 1 4 times the distance of a No. 1 their intensities are practically equal) Adopting fixed lighting like this not only saves space and lighting time but also gives standard intensities, thereby simplifying exposure determinations.

A small closet near by the patient end of the room is desirable for stowing away stand lamps, fully set up. This saves a lot of time in getting ready for a photograph. Camera and film can be stored in a desk or cabinet at the other end of the room

In employing a view type camera with a ground glass focusing back, the same considerations as in the foregoing apply However there is the additional need for a tripod with these cameras and this entails about two feet more space for making full-length records. A place to store the camera on the tripod would save the time required for setting them up

Film packs are available for making black-and-white negatives with most view type cameras These can be loaded in the light, sheet films for special purposes would have to be loaded in a darkroom, and color films too A lighttight closet about 30 x 48 inches would suffice as a loading room in the event that a processing darkroom not be considered. The physician not confining his work to making exposures only would have to arrange space for a processing darkroom. Facilities for both negatives and prints would have to be provided.

Darkroom Items

The selection of darkroom equipment will depend upon the amount and type of work done. There are no special require-

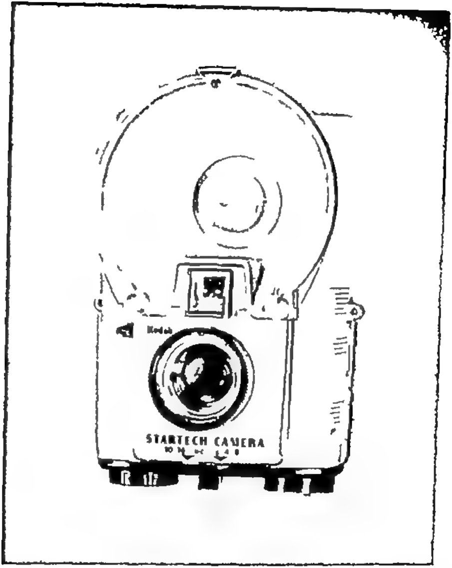


Figure III 1 Close up photography is reduced to its simplest and quickest terms by a camera like the Kodak Startech Camera One adjustment changes the focus for 3½ inch and 6-inch square fields to 9 and 13 inch square areas Parallax is corrected by a *prism moulded into the flashguard to cover the viewfinder* Distance can be guessed instead of measured with a frame because *small apertures provide great depth of field*

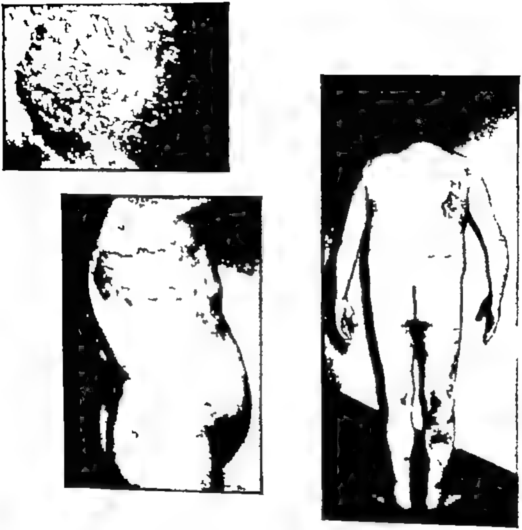


Figure III-8: The scope and usefulness of a three-viewpoint technique described in the text are shown by these close-up half length and full-length records of pemphigus. Most clinical photographs fall in these groups, although an area about the size of the head might replace the half length record in some applications.

Plate IV

ments for medical photography over those for ordinary photography Tanks for developing films and trays for papers are among the standard items that can be suggested by the regular photographic dealer He can also demonstrate contact printers and enlargers. Efficient and sturdy equipment of good quality should be requested

The size of the prints wanted and the type of enlarging equipment on hand have a bearing on the size of the camera selected In general, contact prints of 4 x 5 or 5 x 7 inches are the most practical for routine records For fairly small quantities of photographs it is feasible to print by enlargement and thus a miniature camera becomes practical here Enlargers for negatives up to 4 x 5 inches are usually compact and moderately priced Those accepting 5 x 7 inch or longer negatives are better suited to a photographic department than to a private darkroom because of their size and cost

CHAPTER III SIMPLIFIED TECHNIQUES

Many a physician in his office or clinic has wished for a means of doing both close-up and general clinical photography quickly and easily. He has hoped to achieve good quality without first having to acquire long experience. And he has wanted a compact apparatus that was not limited in practical scope and did not require a major investment in equipment and space. As it turns out, these rather complex and exacting requirements can be met with the simplest camera and lighting system.

Not only will the busy physician be able to direct or carry out a photographic program with the system, but the departmental photographer also will find applications for it. He can delegate rush assignments to even his most inexperienced associates and be assured of good results. Because some are inexpensive, he can afford to place one or two setups in locations where they will be convenient to anyone for routine or temporary projects. In a hospital, a unit would also be valuable for covering emergency conditions at night.

Basically the method involves the use of a miniature camera with attached flash equipment. Such equipment ranges from the simple Kodak Startech Outfit with built-in photoflash lighting (Figure 1) to cameras like the former Kodak Pony camera with a special focal frame (Figure 2) and includes the more precise and elaborate cameras, represented here by the Kodak Retina Reflex (Figure 3) with an electronic flash unit. It should be noted that in this chapter it is this *system* that is under main consideration—the actual equipment is not fundamentally pertinent to the discussion. However the features of the equipment suitable must be those which make the system operable and therefore should be understood.

A brief description of cameras and lights also will be helpful in selecting new cameras, or evaluating one on hand, for the system. From the camera standpoint, the inexperienced will want the simple ones with very few adjustments. For the following reason, these will necessitate the use of supplementary lenses and some means for overcoming parallax (see Chapter IV)

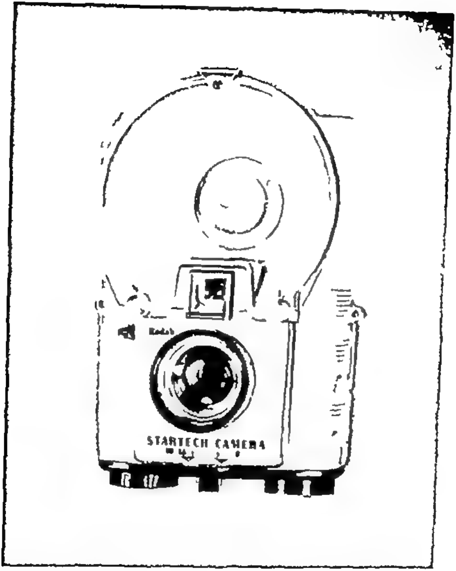


Figure III 1: Close-up photography is reduced to its simplest and quickest terms by a camera like the Kodak Startech Camera One adjustment changes the focus for 3½ inch and 6-inch square fields to 9 and 13 inch square areas Parallax is corrected by a prism moulded into the flashguard to cover the viewfinder Distance can be guessed instead of measured with a frame because small apertures provide great depth of field

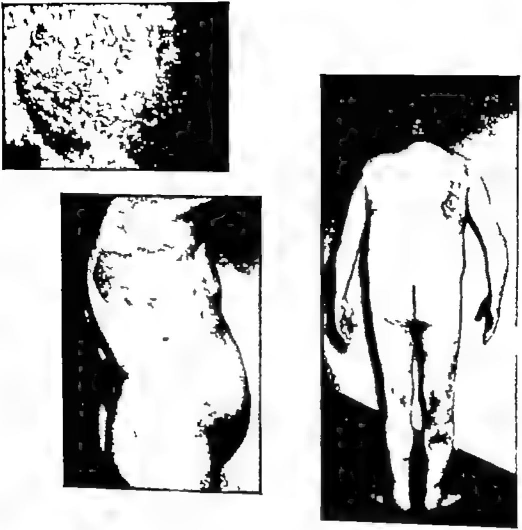


Figure III-8: The scope and useful ness of a three viewpoint technique described in the text are shown by these close-up half length and full-length records of pemphigus. Most clinical photographs f ll in these groups al though an area about the size of the head might replace the half length record in some applications.

Plate IV

Figure IV 10· Depth of field varies with the subject distance At about 9 feet for full length views sufficient depth is obtained at f/8 However f/11 was required for the top photograph because the subjects were one behind the other For close ups at about 6 inches f/22 is needed and the middle photograph was made at that aperture Notice that there is sufficient depth to accommodate a manual operation The depth at extremely close range (bottom) is shallow This record was made at X1½ and at an effective aperture of f/55 (see Chapter IV) Such small rounded subjects at this range require careful selection of the plane of focus—usually at about ⅓ the subject thickness measured back from the front surface

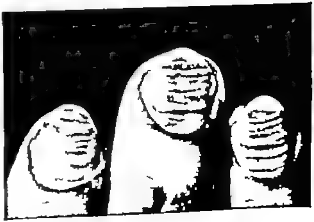


Plate V

An unmodified roll-film camera can make records like Plate II Figure II-5 because the viewfinder is adjusted to the distance for the full-length field. Figure III-4 on the same Plate shows typical medical closeups, and these had to be made with a focal frame instead of with the finder

There are other methods of overcoming parallax. For example a prism over the ordinary view finder will accommodate a limited range Then, for more elaborate cameras, there are continuously variable close range and viewfinders. However those accustomed to handling such equipment can well think in terms of a single-lens reflex camera because of the ease and speed of accurate viewfinding and focusing. It can still be used in the simple system but needs no accessory for parallax correction or for focusing at close range

Figure III-2: Using the simplified technique Lamp simple camera and means for focusing and viewfinding are in one u fit here a focal frame is utilized for the latter Adjustments are kept [illegible] the minimum. The time for each photograph with a focal frame is usually less than a minute because it is merely necessary to aim and release the shutter Fields are limited to those of the frames provided

Figure IV 10: Depth of field varies with the subject distance At about 8 feet for full length views sufficient depth is obtained at f/8 However f/11 was required for the top photograph because the *subjects were one behind the other For close-ups at about 6 inches f/22 is needed and the middle* photograph was made at that aperture Notice that there is sufficient depth to accommodate a manual operation The depth at extremely close range (bottom) is shallow This record was made at X1 ½ *and at an effective aperture of f/55* (see Chapter IV) Such small rounded subjects at this range require careful selection of the plane of focus—usually at about ⅓ the subject thickness measured back from the front surface

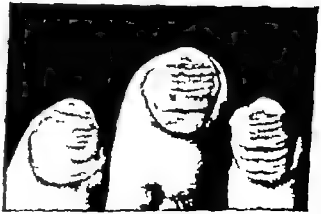


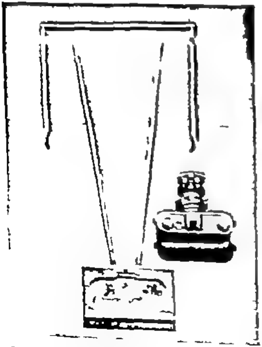
Plate V

For making close work possible close-up rings, or bellows for extending the lens are utilized on some models. On others supplementary lenses (see note on page 45) are employed and these are much quicker to use

The reflex camera should have a diaphragm which automatically closes to a predetermined aperture In this way there is no delay or shifting once the field is in focus.

Focal Frames

Focal frames are available in many styles and applications from a few photographic manufacturers. They are the logical accessory for the simpler cameras. Focal frames also can be improvised for specific uses by the photographer and data on design is given further on. Tables I and II indicate the range of field sizes to be considered. Figure 4 shows typical



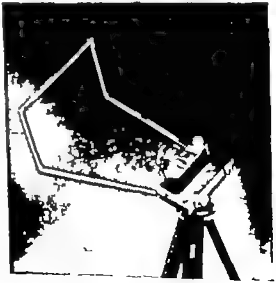


Figure III-6: Focal frame of channel steel for closeup photography *Left*- Disassembled parts. *Right*- Assembly ready for use The optical factors in designing focal frames are given further on.

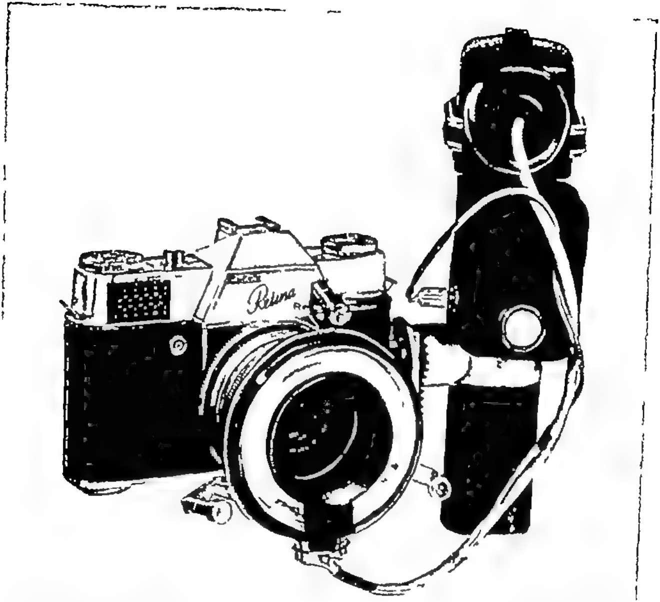


Figure III-3: Precision cameras such as the Retina Reflex require photographic experience to operate and produce the most versatile results They can be used in optimum techniques and also set up for quick operation like the simple cameras Here the single lens reflex system is employed for focusing; that is the camera lens does its own view finding Supplementary lenses provide a *wide range of fields An electronic flash ringlight is one means for providing illumination see* also Chapter VI *(Illustration courtesy Medical Photo Division Lester A. Dine Company Box 55 Levittown N Y)*

TABLE II

TECHNICAL DATA FOR SUPPLEMENTARY LENSES USED ON LARGER ROLL-FILM CAMERAS

Kodak Portra Lens	Focus Setting (in feet)	Working Distance† (in inches)	Subject Dimensions (in inches) for Following Cameras: 2½ × 4¼-in. Camera with 127mm. Lens — Camera Field	Depth of Field‡ N	F	T	2¼ × 3¼-in. Camera with 100mm. Lens — Camera Field	Depth of Field‡ N	F	T
1+	Inf.	38¾	19⅝ × 33⅝	2⅜	2⅝	4⅞	22⅝ × 32	3⅞	4¾	8⅝
	4	21⅝	9⅜ × 16⅜	¾	⅞	1⅝	—	—	—	—
	3½	20⅜	—	—	—	—	10½ × 15¾	1	1	2
2+	Inf.	19½	9¾ × 16¾	⅞	¾	1⅝	11⅝ × 16⅝	1⅛	1¼	2⅜
	4	14	6¾ × 10⅜	¼	⅜	⅝	—	—	—	—
	3½	13⅜	—	—	—	—	6⅞ × 10	½	½	1
3+	Inf.	13	6⅝ × 11	⅜	½	⅞	7½ × 10¾	½	⅝	1⅛
	4	10⅝	4⅜ × 7⅞	⅛	⅛	⅜	—	—	—	—
	3½	10	[illegible]	—	—	—	5⅝ × 7½	⅛	¼	½
			2¼ × 2¼-in. Camera with 75mm. Lens — Camera Field	**Depth of Field‡ N**	**F**	**T**	**1⅝ × 2½-in. Camera with 75mm. Lens — Camera Field**	**Depth of Field‡ N**	**F**	**T**
1+	Inf.	38¾	20 × 20	2¾	3¼	6	21⅝ × 30	2¾	3¼	6
	3½	20⅜	14⅝ × 14⅝	¾	⅞	1⅝	10⅝ × 14⅝	¾	⅞	1⅝
2+	Inf.	19½	14⅜ × 14⅜	⅝	⅞	1⅝	10⅝ × 14¾	¾	⅞	1⅝
	3½	13⅜	8⅞ × 8⅞	¼	⅜	⅝	6⅝ × 8⅞	¼	⅜	⅝
3+	Inf.	13	9⅞ × 9⅞	⅜	½	⅞	7⅝ × 9⅞	⅜	½	⅞
	3½	10	7 × 7	⅛	⅛	⅜	5 × 7	⅛	¼	⅜

The data in this Table are approximate and are intended as a guide in planning a focal frame. Because of the optical characteristics of each combination of camera lens and supplementary lens, photographic tests should be made to determine the exact dimensions of the frame. † Measured from front of supplementary lens ring to subject.

‡ At an aperture of f/8 and for critical depth of field based on a circle of confusion of 1/500 inch. "N" indicates near depth and "F" indicates far depth, both measured from the plane of sharpest focus. "T" indicates total depth, or sum of "N" and "F". Values are rounded to nearest ⅛ inch.

TABLE I

TECHNICAL DATA FOR SUPPLEMENTARY LENSES USED ON 35MM. CAMERAS WITH 50MM. AND 44-46MM. LENSES

Supplementary Lens Combination	Approximate Lens Settings and Subject Dimensions									
	Focus Setting (in feet)	Working Distance† (in inches)	Camera Field (in inches)		Depth of Field (in inches)‡					
					f/8			f/16		
			50mm.	44-46mm.	N	F	T	N	F	T
35mm Cameras										
1 +	Inf 3½	39 20½	18 x 26½ 9 x 13¼	21 x 30 10½ x 15½	5¼ 1¾	7⅜ 2	13⅝ 3¾	9⅛ 2½	16¾ 4⅜	26 7
2 +	Inf 3½	19⅛ 13⅜	8½ x 12½ 6 x 9	10 x 15 6½ x 9⅝	1½ ⅜	1⅜ ⅞	3⅛ 1⅜	2⅞ 1⅜	4⅛ 2⅛	7 3½
3 +	Inf 3½	13 10	5¾ x 8½ 4½ x 6⅜	6¾ x 10 4⅞ x 7¼	⅝ ⅜	¾ ⅜	1⅜ 1	1⅜ ¾	1⅞ 1¼	3¼ 2
3 + 1 +	Inf 3½	10⅛ 8 1/16	4⅝ x 6⅞ 3¾ x 5½	5 1/16 x 7¾ 4 x 6	⅜ ¼	½ ⅜	⅞ ⅝	⅝ ½	⅞ ¾	1½ 1¼
3 + 2 +	Inf 3½	8⅛ 6⅜	3¾ x 5½ 3⅛ x 4⅝	4 3/16 x 6 3/16 3⅓ x 5	¼ ⅛	⅛ ¼	½ ⅜	½ ⅜	½ ⅜	1 ¾
3 + 3 +	Inf 3½	6¾ 5⅜	3 1/16 x 4 5/16 2⅝ x 3 11/16	3 1/16 x 5⅛ 2⅞ x 4¼	⅛ ⅛	¼ ⅛	⅜ ¼	⅜ ¼	⅜ ¼	¾ ½

The data in this Table are approximate and are intended as a guide in planning a focal frame. Because of the optical characteristics of each combination of camera lens and supplementary lens photographic tests should be made to determine the exact dimensions of the frame.

† Measured from front of supplementary lens ring to subject.

‡ For critical depth of field based on a circle of confusion of 1/500 inch. "N" indicates near depth and "F" far depth, both measured from plane of sharpest focus. "T" indicates total depth or sum of "N" and "F". Values are rounded to nearest ⅛ inch. Calculated for 50mm. lenses; 44-46mm. lenses yield practically the same depth of field.

areas encompassed by a 3⅛ x 4⅝-inch frame and a 5+ lens. Figure 5 (bottom) was made with a 35-millimeter camera, focussed at 3½ feet, and a 1+ Kodak Portra Lens; the frame size was 9 x 13¼ inches. It is shown in Figure 8.

It should be remembered, in purchasing or making focal frames, that the greater the number the more complex the equipment. They are always easy to use but a collection of them becomes cumbersome to carry when photography is done in several locations. It also takes more time to fit them and make adjustments. These factors can nullify simplicity.

Accordingly one useful close-up frame about 3¾ x 5½ inches with a 5+ lens combination, is usually all that need be con

TABLE II

TECHNICAL DATA FOR SUPPLEMENTARY LENSES USED ON LARGER ROLL-FILM CAMERAS

Kodak Portra Lens	Focus Setting (in feet)	Working Distance† (in inches)	Subject Dimensions (in inches) for Following Cameras: 2½ x 4¼-in. Camera with 128mm. Lens — Camera Field	Depth of Field‡ N	F	T	2¼ x 3¼-in. Camera with 100mm. Lens — Camera Field	Depth of Field‡ N	F	T
1+	Inf.	38¾	19⅝ 33⅛	2⅜	2½	4⅞	22⅝ 38	3⅞	4¾	8⅝
	4	21⅛	9⅝ 16⅝	¾	⅞	1⅝	—	—	—	—
	3½	20⅜	—	—	—	—	10⅝ 15¼	1	1	2
2+	Inf.	19½	9¾ 16⅝	¾	¾	1⅝	11⅞ 16⅜	1⅛	1¼	2⅜
	4	14	6⅛ 10⅝	¼	⅜	⅝	—	—	—	—
	3½	13⅞	—	—	—	—	6⅞ x 10	½	½	1
3+	Inf.	13	6⅛ 11	⅜	½	⅞	7½ 10¾	½	⅝	1⅛
	4	10⅝	4⅝ 7⅞	⅛	¼	⅜	—	—	—	—
	3½	10	[illegible]	—	—	—	5¼ 7⅝	¼	½	⅝
			2¼ x 2¼-in. Camera with 75mm. Lens — Camera Field	**Depth of Field‡ N**	**F**	**T**	**1⅝ x 2½-in. Camera with 75mm. Lens — Camera Field**	**Depth of Field‡ N**	**F**	**T**
1+	Inf.	38¾	30 30	2¾	3⅛	6	21⅝ x 30	2¾	3⅛	6
	3½	20⅝	14⅝ 14⅞	¾	⅞	1⅝	10⅝ 14⅞	¾	⅞	1⅝
2+	Inf.	19½	14¾ 14¾	¾	[illegible]	1⅝	10⅝ 14¾	¾	⅞	1⅝
	3½	13⅝	8⅞ 8⅞	¼	⅜	⅝	6⅝ 8⅞	¼	⅜	⅝
3+	Inf.	13	9⅞ 9⅞	⅜	½	⅞	7⅝ 9⅞	⅜	½	⅞
	3½	10	7 7	⅛	¼	⅜	5 7	⅛	¼	⅜

The data in this Table are approximate and are intended as a guide in planning a focal frame. Because of the optical characteristics of each combination of camera lens and supplementary lens, photographic tests should be made to determine the exact dimensions of the frame. † Measured from front of supplementary lens ring to subject.
‡ At an aperture of f/8 and for a critical depth of field based on a circle of confusion of 1/500 inch. "N" indicates near depth and "F" indicates far depth, both measured from the plane of sharpest focus. "T" indicates total depth, or sum of "N" and "F". Values are rounded to nearest ⅛ inch.

TABLE I

TECHNICAL DATA FOR SUPPLEMENTARY LENSES USED ON 35MM. CAMERAS
WITH 50MM. AND 44-46MM. LENSES

Supplementary Lens Combination	Approximate Lens Settings and Subject Dimensions									
	Focus Setting (In feet)	Working Distance† (In inches)	Camera Field (in Inches)		Depth of Field (in Inches)‡					
					f/8			f/16		
			50mm	44-46mm.	N	F	T	N	F	T
35mm Cameras										
1 +	Inf 3½	39 20½	18 x 26½ 9 x 13¼	21 x 30 10½ x 15½	5¼ 1¾	7⅜ 2	13⅝ 3¾	9¼ 2½	16¾ 4½	26 7
2 +	Inf 3½	19¼ 13⅝	8½ x 12½ 6 x 9	10 x 15 6½ x 9⅝	1⅞ ¾	1⅜ ⅞	3¼ 1⅝	2⅞ 1⅜	4⅛ 2⅛	7 3½
3 +	Inf 3½	13 10	5¾ x 8½ 4⅛ x 6⅛	6¾ x 10 4⅞ x 7¼	⅝ ⅜	¾ ⅝	1⅜ 1	1⅜ ¾	1⅞ 1¼	3¼ 2
3 + 1 +	Inf 3½	10⅛ 8 1/16	4⅝ x 6⅞ 3¾ x 5½	5 1/16 x 7¾ 4 x 6	⅜ ¼	½ ⅜	⅞ ⅝	⅝ ½	⅞ ¾	1½ 1¼
3 + 2 +	Inf 3½	8⅛ 6⅝	3⅝ x 5⅛ 3⅛ x 4⅝	4 1/16 x 6 1/16 3⅜ x 5	¼ ⅛	¼ ¼	½ ⅜	½ ⅜	½ ⅜	1 ¾
3 + 3 +	Inf 3½	6⅝ 5⅝	3 1/16 x 4 11/16 2⅝ x 3 11/16	3 1/16 x 5⅛ 2⅞ x 4¼	⅛ ⅛	¼ ⅛	⅜ ¼	⅜ ¼	⅜ ¼	¾ ½

The data in this Table are approximate and are intended as a guide in planning a focal frame. Because of the optical characteristics of each combination of camera lens and supplementary lens photographic tests should be made to determine the exact dimensions of the frame.

† *Measured from front of supplementary lens ring to subject.*

‡ For critical depth of field based on a circle of confusion of 1/500 inch "N" indicates near depth and "F" far depth; both measured from plane of sharpest focus. "T" indicates total depth or sum of "N" and "F". Values are rounded to nearest ⅛ inch. Calculated for 50mm. lenses; 44-46mm. lenses yield practically the same depth of field.

areas encompassed by a 3⅛ x 4⅝-inch frame and a 5+ lens. Figure 5 (bottom) was made with a 35-millimeter camera, focussed at 3½ feet, and a 1+ Kodak Portra Lens; the frame size was 9 x 13¼ inches. It is shown in Figure 6.

It should be remembered, in purchasing or making focal frames, that the greater the number the more complex the equipment. They are always easy to use but a collection of them becomes cumbersome to carry when photography is done in several locations. It also takes more time to fit them and make adjustments. These factors can nullify simplicity.

Accordingly, one useful close-up frame about 3¾ x 5¼ inches with a 5+ lens combination, is usually all that need be con

sidered. This can be supplemented in some applications with a medium frame of about 9 x 13¼ inches, which would encompass the entire face of a patient.

The size of the close-up frame was established after discussions with physicians as to the most useful, single, close-up field. Illustrations in medical and scientific journals were also reviewed. The record obtained may be considered as representing the normal close-up appearance of a lesion or object. Some tiny objects will look small (and thus not unnatural) in the field selected, but the gross characteristics will be clearly depicted. The only way to photograph them any closer is to magnify them with much more elaborate equipment. This is beyond the aims of the simplified technique and the needs of most physicians. When a single frame is utilized it is handy to have it just enough larger than the camera field to obviate the need for taking it off when the camera is used in the ordinary way for half length and full-length records.

It should not be overlooked that focal frames can be used, with standardized (Figure 7) or even optimum lightings. However for them in particular care must be taken that a shadow of the frame does not fall in the picture area.

Three-view Photography

Regardless of the method of view finding in the simplified technique, it saves time and simplifies the system to adopt three routine field sizes or viewpoints for most of the work.

It is safe to assume that a physician's interest in a clinical surface condition, such as a dermatologic lesion, might be first centered on a relatively small area. Next, adjacent regions might be examined for pattern of involvement, and, finally the manner in which the entire body is affected might be observed.

From the foregoing, the complete clinical examination from a photographic standpoint might be considered to entail a three view observation of the patient, including close-up regional or half length, and full-length fields (Figure III-8, Plate IV page 35) Then, in recording a given case just the views desired need be photographed—all three will not always be required.

Another advantage of standard view points is that this procedure greatly facili-

←

Figure III-7 This close-up of the shoulder area of a slender subject shows the smallest field obtainable with a Kodak Portra Lens 1+ and a 35-millimeter camera. A focal frame was utilized. Standardized lighting in a simplified setup was employed. Two lamps are well suited to photographing rounded or complex areas, especially when the purpose is that of "mapping" lesions.

→

distance. These factors explain the excellent results obtainable with most subjects by the method.

Photoflash units are available for all present-day miniature cameras and they are synchronized by means of the camera shutter. The B-C (battery-capacitor) type is most reliable in operation. Electronic flash units for attaching to the camera can also be used in the system. Some have to be plugged into a power line; others operate on batteries, and still others offer both features.

For most work the lamp can be about 6

TABLE III

LIGHTING AND EXPOSURE DATA FOR CLOSE-UP PHOTOGRAPHY

Lamps*	Suggested Field Sizes (in inches)		Distance of Light from Subject† (in inches)		Exposures	
			Main Modeling Light	Fill-in Light	Color	Black and White
					*For Films of Index 16	*For Films of Index 64
No. 2 Photoflood‡	9	13½	24	34	1/50 sec. at f/4	1/50 sec. at f/11
Reflector Photoflood (RFL-2)	9	13½	24	34	1/50 sec. at f/4.5	1/50 sec. at f/11-16
	6 3¾ 1⅞	9 5½ 2¾	17	24	1/50 sec. at f/6.3	1/50 sec. at f/16-22
Reflector Photospot (RSP-2)**	3¾ 1⅞	5½ 2¾	24	34	1/50 sec. at f/8	1/50 sec. at f/22
Photoflash			Single Bulb		Type F Index 12	For Films of Index 20
No. 5 or 25 3-4 shiny reflector	9 6	13½ 9	50 36		1/25 sec. at f/22 1/200 sec. at f/16-22	1/50 sec. at f/22 1/200 sec. at f/22
M5 2 shiny reflector	9 6	13½ 9	48 36		1/25 sec. at f/22 1/100 sec. at f/16	1/50 sec. at f/22 1/100 sec. at f/22
No. 5 or 25 blackened reflector	3¾ 2⅝	5½ 3⅞	9		1/500 sec. at f/22	1/500 sec. at f/22‡‡
M5 blackened reflector	2⅝ 1⅞	3 2¾	6		1/500 sec. at f/22	1/500 sec. at f/22‡‡

Main light at about 30° lighting angle and about 4 inches higher than camera. Fill-in light at 1.4 times distance of main light, close to camera-subject axis for small lighting angle, and at camera height.

When photoflash lamps are used close to subject it is extremely important that adequate protection be provided for those present against accidental explosion of the bulb as a result of the flash.

Film Exposure Indexes for tungsten illumination are discussed in Chapter VII.

‡ In matte reflector.

** This lamp is chiefly useful for lighting cavities, because of the heat it radiates it should not be used closer than 2 feet, and then only for very brief periods.

‡‡ Exposure can be reduced and red rendition improved with Kodak Wratten No. 66 Filter.

tates comparison of the records made of existing and future cases The full length field for children of course will not be as large as for adults ordinary focussing can accommodate this difference

The sizes of frames for this method has been discussed above For single-lens reflex cameras, similar fields can be obtained and the means will depend on the camera For example the Retina camera yields a field 5½ inches in the longer dimension with the R 1 4.5 supplementary lens and infinity camera focus The head can be encompassed in a 15-inch field with the NI lens and 5-feet focus Without a supplementary lens and at 2½ feet focus the half length records are possible And at 9-feet focus a 6-foot patient can be photographed By limiting the photography to routine prescribed field sizes, work with even an elaborate miniature camera can be greatly simplified and speeded up

No Darkroom Required

The use of miniature films eliminates the need for a darkroom for either loading or processing Color transparencies are returned from the processing station ready to project as 2 by 2 inch slides Efficient semi automatic projectors can be employed, even in lighted classrooms and meeting halls Such facilities make the color slide one of the most useful types of photographic record Black and white illustrations for publications in journals can be made from the transparencies and from color negatives or black and white negatives Physicians associated with an institution having a centralized photographic department can well avail themselves of its technical services

When lights are added, simplified units become complete photographic installations that can be carried in one hand

Lighting Units

Flash units on the camera are employed. While these do not lead to optimum lighting for all subjects they provide a practical and excellent lighting for general medical photography This will be apparent from the illustrations shown in Plates II III IV V and VII (page 116) All these records were made with such a lighting system In comparison optimum lighting methods were employed for Plate I (frontispiece) and Plate VI (page 115) and for most of the black and white illustrations

The plates are well worth studying. There has been some question as to the adequacy of single lights at the camera because of the almost axial lighting. This has grown out of the early days of flash press photography However rapid reproduction on coarse newspaper stock does not lend itself to the rendition of fine detail and gradation whereas a good original print or slide can do this. Another point to remember is that when the simplified technique is utilized for close-ups the lighting is no longer axial but is angulated because of the relatively short subject lens

distance These factors explain the excellent results obtainable with most subjects by the method.

Photoflash units are available for all present-day miniature cameras and they are synchronized by means of the camera shutter The B-C (battery-capacitor) type is most reliable in operation. Electronic flash units for attaching to the camera can also be used in the system. Some have to be plugged into a power line· others operate on batteries, and still others offer both features.

For most work the lamp can be about 8

TABLE III

LIGHTING AND EXPOSURE DATA FOR CLOSE-UP PHOTOGRAPHY

Lamps	Suggested Field Sizes (in Inches)		Distance of Lights from Subject† (in Inches)		Exposures	
			Main Modeling Light	Fill-in Light	Color	Black and White
					*For Films of Index 16	*For Films of Index 64
No. 2 Photoflood‡	9	13 1/4	24	34	1/50 sec. at f/4	1/50 sec. at f/11
Reflector Photoflood (RFL-2)	9	13 1/4	24	34	1/50 sec. at f/4.5	1/50 sec. at f/11 16
	6 3 1/2 1 7/8	9 5 1/4 2 3/4	17	24	1/50 sec. at f/6.3	1/50 sec. at f/16-22
Reflector Photospot (RSP 2)**	3 1/2 1 7/8	5 1/4 2 3/4	24	34	1/50 sec. at f/8	1/50 sec. at f/22
Photoflash			Single Bulb		Type F Index 12	For Films of Index 20
No. 5 or 25 3 -4 shiny reflector	9 6	13 1/4 9	50 36		1/25 sec. at f/22 1/200 sec. at f/16-22	1/50 sec. at f/22 1/200 sec. at f/22
M5 3 shiny reflector	9 6	13 1/4 9	48 36		1/25 sec. at f/22 1/100 sec. at f/16	1/50 sec. at f/22 1/100 sec. at f/22
No 5 or 25 blackened reflector	3 1/2 2 5/8	5 1/4 3 7/8	9		1/500 sec. at f/22	1/500 sec. at f/22‡‡
M5 blackened reflector	2 1/2 1 7/8	3 7/8 2 3/4	6		1/500 sec. at f/22	1/500 sec. at f/22‡‡

Main light at about 30° lighting angle and about 4 inches higher than camera. Fill-in light at 1.4 times distance of main light, close to camera-subject axis for small lighting angle, and at camera height.

† When photoflash lamps are used close to patient it is extremely important that adequate protection be provided for those present against accidental explosion of the bulb as a result of the flash.

Film Exposure Indexes for tungsten illumination are discussed in Chapter VII.

In matte reflectors.

** This lamp is chiefly useful for lighting cavities; because of the heat it radiates it should not be used closer than 2 feet, and then only for very brief periods.

‡‡ Exposure can be reduced and red rendition improved with Kodak Wratten No. 66 Filter

inches to the side of the lens axis with rare exceptions (dealt with in Chapter VI) the bulb should also be above the level of the lens Ideally the lamp should be ca pable of being moved from one side to the other

Electronic flash ringlights are chiefly useful for lighting cavities (see Chapter VI) They can be used for other subjects successfully especially in color work al though they do not provide quite so much modeling. A good trick to keep in mind when using ringlights or another light very close to the lens axis is to avoid shooting perpendicularly to any flat sur face In this way glare off the subject can be precluded

A big advantage of using flash illumina *tion for close-ups is the fact that there is* abundant light This permits the photog rapher to stop the lens down to its smaller apertures and thus obtain the depth-of field needed Most electronic flash close-up units need no further reduction in image brightness to provide good exposures Photoflash bulbs yield much more illumination however necessitating some *means for reducing intensity* Utilizing the faster shutter speeds of precision cameras accomplishes this end see Table III For extremely close work, the brightness can be reduced further by blackening an extra reflector (on flashholders having detach able reflectors) with matte black lacquer When the fast speeds cannot be synchron ized with the lamps, a special flashguard can be improvised This is done by lining one side of the plastic guard (inside) with thin sheet aluminum. Holes 3/16-inch in diameter can be punched cleanly out of this baffle and the number needed can be found by trial

Utilizing a blackened reflector is an ad *vantage for two reasons besides light re* duction The bulb alone constitutes a rela *tively small light source which produces* a minimum of highlights on glistening subjects It also casts sharper shadows than a bulb in a shiny reflector and, therefore, emphasizes texture.

When photoflash lamps are used close to the patient it is extremely important that adequate protection be provided for those present against accidental explosion *of the bulb as a result of the flash* Flash guards for the purpose are on the market Some photographers have made their own shields out of ⅛-inch transparent plastic. These ought not be fitted tight to the reflector or the confined gases might break the guard

Photoflood Lighting

The utilization of photoflood lamps comes more generally under the con siderations for setups discussed in Chap*ter VI Since they can be used with focal* frames, however a brief discussion is warranted here.

A standardized lighting system can be adopted in medical close-up photography *with focal frames. It is somewhat more* suitable for recording rounded subjects

like the head or breast, particularly when pattern rather than form is involved, see Figure 7. One light at a 30-degree lighting angle provides sufficient modeling to show up contours, a fill-in light, as close as possible to the lens-subject axis and at 1.4 times the distance of the modeling light, illuminates the shadows.

A glancing lighting for sharp delineation of textures necessitates placing a photoflood lamp at a considerable angle from the camera axis. This is usually not feasible with focal frames because their sides would cast shadows. This type of lighting is more readily obtained with view-type cameras and is discussed in a subsequent chapter. Also, since photoflash lamps represent smaller sources, especially in blackened reflectors, they are capable of producing crisper illumination. Hence the flash-holder system is often more feasible, although not so economical as the use of photoflood lamps.

The sketches in Figure 9 show photoflood setups for small and large frames. Data in Table III are given on the basis of this lighting system.

General Electric Reflector Photofloods No. RFL-2 or Reflector Photospot Lamps No. RSP-2 make compact lighting setups feasible. However, since they give off considerable heat—especially the photospot lamps—a dimmer is a very desirable accessory. Subject movement is sometimes a serious problem, making the adoption of a photoflash technique desirable for many applications. This is particularly true in photographing the eye, because, in addition to being

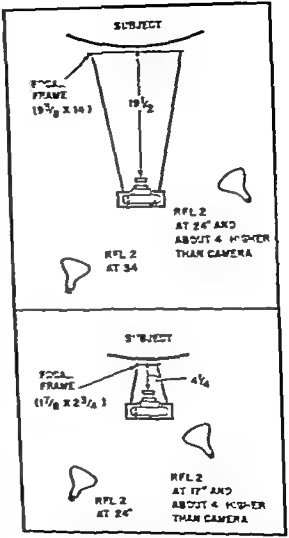


Figure III-9: Standardized lighting diagrams for use with large and small focal frames showing placement of modeling light (right) and fill-in light (left). For convenience the lights can be affixed to bars supported by the camera base.

inches to the side of the lens axis, with rare exceptions (dealt with in Chapter VI) the bulb should also be above the level of the lens Ideally the lamp should be ca pable of being moved from one side to the other

Electronic flash ringlights are chiefly useful for lighting cavities (see Chapter VI) They can be used for other subjects successfully especially in color work al though they do not provide quite so much modeling A good trick to keep in mind when using ringlights, or another light very close to the lens axis is to avoid shooting perpendicularly to any flat sur face In this way glare off the subject can be precluded

A big advantage of using flash illumina tion for close-ups is the fact that there is abundant light This permits the photog rapher to stop the lens down to its smaller apertures and thus obtain the depth-of field needed Most electronic flash close-up units need no further reduction in image brightness to provide good expo-sures. Photoflash bulbs yield much more illumination however necessitating some means for reducing intensity Utilizing the faster shutter speeds of precision cameras accomplishes this end see Table III For extremely close work, the brightness can be reduced further by blackening an extra reflector (on flashholders having detach-able reflectors) with matte black lacquer When the fast speeds cannot be synchron ized with the lamps, a special flashguard can be improvised This is done by lining one side of the plastic guard (inside) with thin sheet aluminum Holes $\frac{3}{16}$-inch in diameter can be punched cleanly out of this baffle and the number needed can be found by trial

Utilizing a blackened reflector is an ad vantage for two reasons besides light re duction The bulb alone constitutes a rela tively small light source, which produces a minimum of highlights on glistening subjects. It also casts sharper shadows than a bulb in a shiny reflector and, there-fore, emphasizes texture

When photoflash lamps are used close to the patient it is extremely important that adequate protection be provided for those present against accidental explosion of the bulb as a result of the flash Flash guards for the purpose are on the market Some photographers have made their own shields out of ¼-inch transparent plastic. These ought not be fitted tight to the re-flector or the confined gases might break the guard

PHOTOFLOOD LIGHTING

The utilization of photoflood lamps comes more generally under the con siderations for setups discussed in Chap-ter VI Since they can be used with focal frames, however a brief discussion is warranted here

A standardized lighting system can be adopted in medical close up photography with focal frames. It is somewhat more suitable for recording rounded subjects

like the head or breast, particularly when pattern rather than form is involved, see Figure 7. One light at a 30-degree lighting angle provides sufficient modeling to show up contours, a fill-in light, as close as possible to the lens-subject axis and at 1.4 times the distance of the modeling light, illuminates the shadows.

A glancing lighting for sharp delineation of textures necessitates placing a photoflood lamp at a considerable angle from the camera axis. This is usually not feasible with focal frames because their sides would cast shadows. This type of lighting is more readily obtained with view-type cameras and is discussed in a subsequent chapter. Also, since photoflash lamps represent smaller sources, especially in blackened reflectors, they are capable of producing crisper illumination. Hence the flash-holder system is often more feasible although not so economical as the use of photoflood lamps.

The sketches in Figure 9 show photoflood setups for small and large frames. Data in Table III are given on the basis of this lighting system.

General Electric Reflector Photofloods (No. RFL-2) or Reflector Photospot Lamps (No. RSP 2) make compact lighting setups feasible. However since they give off considerable heat—especially the photospot Lamps—a dimmer is a very desirable accessory. Subject movement is sometimes a serious problem, making the adoption of a photoflash technique desirable for many applications. This is particularly true in photographing the eye, because, in addition to being

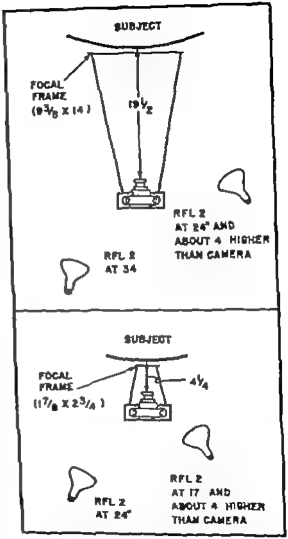


Figure III-9: Standardized lighting diagrams for use with large and small focal frames showing placement of modelling light *(right)* and fill-in light *(left)*. For convenience the lights can be affixed to bars supported by the camera base

subject to movement, the eye cannot tolerate the brightness of the tungsten illumination that would be required for photography at a small aperture.

A photoflood setup can be made easier to use if the lamps are attached to the camera base. Gooseneck fixtures can be utilized for providing lamp adjustments

Supplementary Lenses

In contrast to a view type camera, which is focused at close range by increasing the lens film distance, most roll film cameras can be focused on near by subjects only by means of supplementary lenses Their optical power is indicated by 1+ 2+ 3+ the designation for 1 2, and 3 diopters * respectively Supplementary lenses can be used in combination, one in front of the other their powers are then added For example two 3+ lenses yield 6 diopters Greater powers than this up to 15 diopters are practical with miniature cameras Unless specially designed lenses are utilized, such powers are best obtained with single periscopic spectacle lenses which can be furnished by an optician and edge-ground to fit camera attachments

The stronger the supplementary lens or combination of lenses used the smaller the field size that can be made to fill the negative Table I shows the sizes of the areas photographed with 35 mm cameras having 50 and 44 mm lenses when fitted with supplementary lenses The working distances and depth of field are also given

Data in the Table are given for the two limits of the focusing scale The simplest way to work is to adopt either limit as a fixed setting and change supplementary lenses to suit the fields wanted

One or more supplementary lenses can be held in place on the camera lens by suitable lens attachments that are available for the purpose If two unequal supplementary lenses are to be used, the stronger one should be placed next to the camera lens

The question is sometimes raised as to whether supplementary lenses "destroy" the camera lens definition Actually the opposite can be true. When a supplementary lens of high quality is placed over a fine camera lens set at the infinity focus the resultant definition is usually better say at a 30-inch working distance, than that which can be obtained by focusing the camera with its own lens at 2½-feet The reason is that camera lenses have their best correction at a distance and a reduction in definition occurs when the lens film distance is increased for closer focusing The differences are more academic than practical, however because it is difficult to pick them up in practice. Another factor is that any form of close-up focusing reduces depth-of field so that a small aperture is needed and here most lens corrections that affect definition are less dominant. The crux of the matter is that good

* The diopter is a unit of lens power and is 1/F where F is the focal length expressed in meters.

supplementary lenses can be used with confidence

Designing Focal Frames

There are focal frames, and devices like distance and centering rods, which accomplish the same ends, on the market. However the photographer may want a specialized frame or one to fit a specific camera on hand. A knowledge of the technical aspects can be helpful and can also aid in the intelligent selection of manufactured equipment.

As pointed out before the simplified technique is simple and quick in operation—this does not mean that elaborate cameras and photographic knowledge has no bearing on it. The expert can make a simplified setup; the beginner can buy one. Both can then equally enjoy the benefits.

It will be well first to understand the properties of supplementary lenses (given above) since they figure so often in the simplified technique.

The focal frame consists of a base for holding the camera, and a frame and support of cold rolled steel or aluminum rods or channels. The unit can be constructed in collapsible form or in a single piece. In order to prevent the frame from appearing in the picture it should be made about 10 per cent larger than the field it is to delineate; this also helps to minimize shadows in the field cast by the frame. L-shaped frames are even better in this respect. The length of the supporting rods for the larger frames should be such that in use the frame will be located about ¼-inch away from the subject. This precludes having the frame touch patients. However when smaller frames, such as the 1⅞ x 2¾-inch, are used, they will have to be set in the plane of the subject to prevent objectionable shadows from them appearing in the field. The finish and construction of the frames should permit sterilization.

To make a frame of a size selected from data given in Tables I or II, approximate measurements can be worked out on the basis of the tabulated figures. However because of certain optical factors, the precise working distance and field size for an individual combination of camera and supplementary lenses must be determined by trial.

A series of frames can be made for specific uses. In medical work with a miniature camera the following field sizes would cover a large number of specialized applications: 1⅞ x 2¾-inches (with a 10+ lens); 3¾ x 5⅝-inches (with a 3+ and 2+ lens in combination); 5¾ x 8½-inches (with a 3+ lens); and 9 x 13½-inches (with a 1+ lens.)

TESTING. The exact working distance can be found by photographing a ruler in the following way: Stand the camera on a bench. Support the ruler face up on a block or piece of modeling clay so that the rear end is directly beneath, and

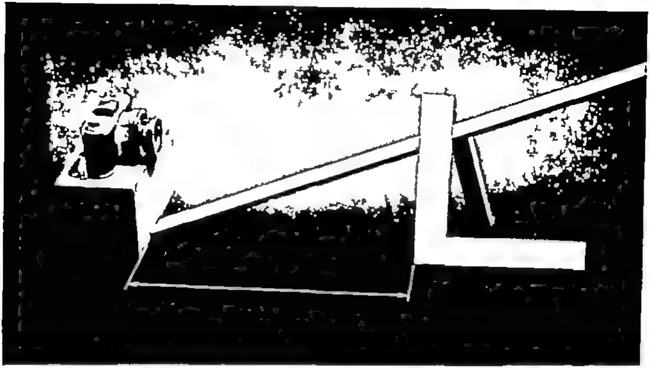
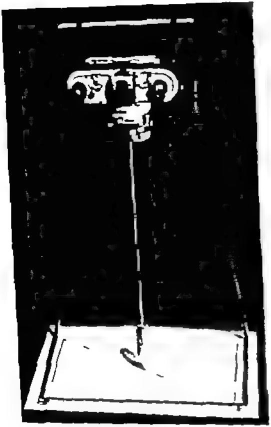


Figure III 10: Methods of aligning focal frames *A* **A setup for photographing a ruler to find the actual working distance The square is set beside the undisturbed slanted ruler after** *the negative has been examined for the sharpest index number; then the working distance is* **measured (on the bench) to the block** *B* **A plumb bob and spirit level used to center the lens in the frame The bob hangs from a hole in a card temporarily put in place of the supplementary lens**

→

about six inches below the bottom of the lens. Rest the far end on a larger block so as to slope the ruler upward. The amount of slope should be such that the figure on the ruler corresponding to the working distance selected from the Table is about the same height above the bench as the center of the lens (see Figure 10) Make a picture at an aperture of about f/4.5. This will limit the depth-of field and thus emphasize the marking on the ruler that is in sharpest focus, indicating the actual working distance for the combination of lenses. The field size can be found by photographing two rulers at the actual working distance The simplest way to do this is to tape them to a wall in the form of a cross. The camera lens should be located at the same height as the point at which the rulers cross, and the camera axis directed squarely toward the center of the horizontal ruler Two photographs have to be made if only one ruler is available—



← Figure DI-10B

one with it vertical and the other with it horizontal.

After the frame is constructed, the easiest way to align it accurately in front of the camera is by means of a beam of light projected through the camera lens, provided the camera is so constructed as to allow the procedure. The method is as follows: The camera is set for the correct focusing distance, the lens opened to full aperture and the shutter opened on "T" Then the camera is placed firmly in position on the block for the frame, and the back opened to uncover the film tracks. Across them a small piece of ground glass is taped with the matte side in the film plane A pencil mark should be made on the ground surface. The room lights are extinguished and the opal glass illuminated with a flashlight. A rectangular patch of light, with a sharp image of the mark, will appear in the field plane of the camera, which indicates both the size and position of the field. The frame should be adjusted so that the patch is centered within it.

If the front of the camera cannot be held in place or the film plane cannot be uncovered for the above method, a procedure should be adopted which utilizes a spirit level and plumb bob as follows Place the frame face down on a smooth surface that has been checked with the spirit level. Seat the camera in its base and attach the latter to the now upright supporting rods for the frame Hang the plumb bob under the center of the camera lens, an easy way is to substitute temporarily a circle of cardboard for the supplementary lens and thread the string through a hole in its center Adjust the attachment of the rods to the camera base until the bob hangs in the center of the frame making sure that the camera is level. Photographic tests can be made if desired, to provide a final check on alignment and distance Coarse graph paper makes a good test object

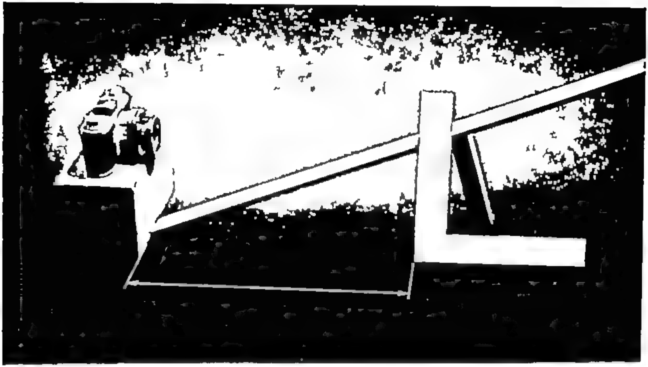


Figure III 10: *Methods of aligning focal frames* **A** A setup for photographing a ruler to find the actual working distance The square is set beside the undisturbed slanted ruler after the negative has been examined for the sharpest index number; then the working distance is measured (on the bench) to the block **B** A plumb bob and spirit level used to center the lens in the frame The bob hangs from a hole in a card temporarily put in place of the supplementary lens

→

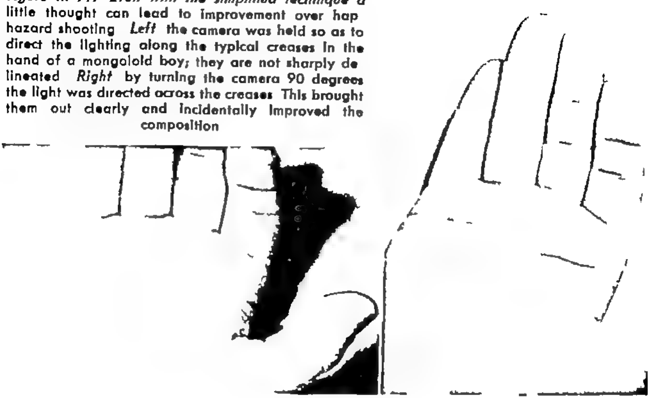
about six inches below the bottom of the lens. Rest the far end on a larger block so as to slope the ruler upward. The amount of slope should be such that the figure on the ruler corresponding to the working distance selected from the Table II about the same height above the bench as the center of the lens (see Figure 10) Make a picture at an aperture of about f/4.5 This will limit the depth-of field and thus emphasize the marking on the ruler that is in sharpest focus, indicating the actual working distance for the combination of lenses. The field size can be found by photographing two rulers at the actual working distance The simplest way to do this is to tape them to a wall in the form of a cross. The camera lens should be located at the same height as the point at which the rulers cross, and the camera axis directed squarely toward the center of the horizontal ruler Two photographs have to be made if only one ruler is available—

fects of camera and subject movement. They are available for power lines or batteries.

While the focal frame setup is primarily intended to permit using the camera in the hand, a tripod or other support is sometimes valuable. For example, in making photographic surveys of the eye or mouth, it is time-saving to have the setup fixed and to position each subject at the frame instead of bringing the camera up to the patients. For full-length records, patients should be placed about 1 foot away from a plain, dull-finished wall to minimize the shadow (see Figure II-5 Plate II, page 29) If the finish is glossy a reflection of the light may be avoided by placing the patient against the wall and locating the camera 8 feet away and 4 feet to one side In this way the 9-foot subject lens distance is maintained but the camera axis is now about 60 degrees to the wall. The patient should be posed, of course so that the area to be photographed faces the camera. This is demonstrated in Figure III-8 Plate IV page 35. When hands or feet are photographed in a clinic, a paper towel can be used as a background. In a more permanent location blotters or cards are suitable see Figure III-5 page 30

The demonstration in Figure 11 shows how to get the most out of the simplified technique The aim and shoot procedure yields excellent results for most subjects. Experience will suggest certain tricks that lead to better records of some conditions The simple method is the best one to start with, even for those who wish to go farther It is also time-saving for the busy photographer The main reason for gaining photographic proficiency through learning other techniques is to gain a background for handling any and all subjects with confidence

Figure III 11: Even with the simplified technique a little thought can lead to improvement over hap hazard shooting *Left* the camera was held so as to direct the lighting along the typical creases in the hand of a mongoloid boy; they are not sharply de lineated *Right* by turning the camera 90 degrees the light was directed across the creases This brought them out clearly and incidentally improved the composition



Practical Hints

A simplified setup is quite easy and quick to use There are however a few points that should be kept in mind Foremost is the fact that as small an aperture as possible should be employed for close-ups so that sufficient depth-of field can be provided. It is also advisable to set the shutter for at least 1/50 second when the camera is hand held. These factors require bright illumination—usually photoflash. When only a moderate amount of photography is done photoflash lamps are the most economical. With flash holders there are no dangling wires to become twisted and no electrical components to be carried around The lighting is produced by a small battery and midget photoflash lamps. Even when the camera is hand held, these supply enough light to permit photography at an aperture of f/22 for great depth-of field

Electronic flash units entail a greater initial expenditure but the lamps are good for thousands of flashes Therefore they should be considered for a busy photographic program They minimize the ef

Basic Principles

The behavior of light rays and the powers of the lenses impose certain conditions on the methods of using cameras. Working distances, lens speeds, perspective, angle of view covering power, and depth of field are all aspects to photography that gradually become part of the photographer's technical skill.

IMAGE FORMATION The subject to be photographed can be thought of as a collection of tiny dots somewhat like a halftone illustration. Each dot reflects an amount of light toward the lens that depends on the brightness of the subject at that point. The rays entering the lens from any given dot pass through and are converged to form another dot of light—an image. The image of the entire subject may then be said to consist of a collection of dots similar in brightness and distribution to the original ones. The position and nature of the image can be deduced by tracing the rays of light from a single dot through the lens to the corresponding image dot. Figure 1 shows this principle as applied to photographing a two-dimensional subject. Notice how those rays of light leaving "X" that are intercepted by the lens have formed a cone. This cone has been refracted by the lens and transmitted as a reversed cone of rays on the image side of the lens. On a piece of ground glass, placed at the apex of the image cone, the image of X appears as a sharp point. X is "in focus" on the ground glass and the latter is in the "focal plane."

If the ground glass were moved closer to the lens, the point of the cone would be cut off and a disk of light, rather than a sharp point, would appear on the ground glass, as indicated by the dotted outline in front of the image. This disk is called the "circle of confusion." Its size obviously depends on the displacement of the ground glass. Moving the ground glass away from the lens also causes circles of confusion to appear because the light rays spread again if the image cone is not intercepted at the focal plane. This is shown in Figure 1 where the reformed image cone has been terminated.

Assuming that a lens of good quality is being used to copy this original, all of the subject points will come to a focus in the same plane. Therefore, a sharp image of the drawing can be produced on the film by placing it in the position of the ground glass. The resulting negative image would be made up essentially of sharp image dots *side by side*. On the other hand, were the film displaced from the focal plane, the image would be made up of *overlapping* circles of confusion. The negative would be fuzzy or out of focus. Fine details of the subject could not be printed from such a negative any more than they could be painted on canvas with a coarse brush.

Focal Length

The focal length of a lens is its chief distinguishing property and depends on its

CHAPTER IV LENS PROPERTIES

THE versatility of view type cameras imposes a need for understanding a few optical fundamentals The question "How much lens theory must I have?" often arises Happily only a smattering of theory is necessary for the production of most medical photographs But no photographer can confidently carry out all the assignments that come along without some knowledge of image formation

This point can be emphasized by considering the amount of photographic theory that is applied out of habit. Take, for example the development of a negative. Here the photographer does not need a command of the intricacies of the latent image theory but he does have to know that the exposed film goes into the developer first The instructions packed with the film tell him how long to develop at 68 F but what if he hasn t the time or means for keeping his solution at that temperature? Then he applies a little more theory—the effect of temperature on development

And so it is in handling a camera Every one knows that the subject must be on one side of the lens and the film on the other But a knowledge that goes beyond this is needed even by the box-camera user because the simplicity of his camera imposes limitations in focusing and exposure The medical photographer who uses more complex equipment must gradually acquire a good practical understanding of the fundamentals of lens theory In that way haphazard methods can be avoided in handling some of the more exacting problems he meets

infinity focus is the plane closest to the back of the lens in which an image can be formed. As the focusing distance is made less than infinity the focal planes move farther away from the back of the lens—the bellows has to be extended. Obviously then, if a camera is to be focused at infinity it must be constructed with a bellows or tube at least as long as the focal length of its normal lens. A double-extension (two focal lengths) bellows is required for same-size photography since at this scale the image plane is located at two focal lengths behind the lens. (Under these conditions, the subject-lens distance is also two focal lengths.)

The focal length of a lens governs the size of the image. For a fixed subject-lens distance the image becomes larger as the focal length is increased. The larger a negative is, therefore the longer the focal length of the lens has to be for use with it. All lenses of the same focal length yield the same image size at a given distance.

Working Distances

When considering the effect of focal length on working distance it should be remembered that the shorter the focal length, the shorter is the subject lens distance for a given image size. However all cameras with normal lenses require substantially the same working distance for a field of a given size to fill their negative areas. They are for example nine feet of distance for a seven-foot field on the long

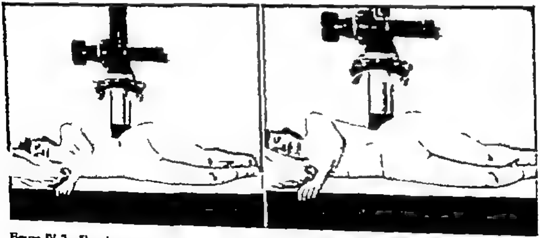


Figure IV 2: Showing use of lens of scanty focal length in photographically cramped quarters. *Left* 7½-inch lens was used on a 5 x 7-inch camera because working space was not sufficient to permit taking in the entire field with a lens of longer focal length normally employed on this camera. *Right* Shows how field is "trimmed" when a lens of normal 8-inch focal length is utilized in cramped space.

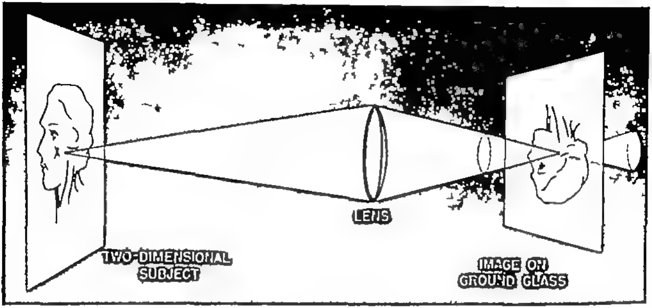


Figure IV 1: Diagram showing how a point of light on a two-dimensional subject is focused by the lens onto a ground glass in the focal plane If the glass is moved toward or away from the lens the point would be imaged as a circle (dotted line) whose size depends on the displacement of the glass

power This is governed by the curvatures locations and refractive indices of the glass elements Defining the focal length rigidly is beyond the scope of this book Here is a practical definition The focal length of a lens is approximately the distance from the diaphragm to the film when the camera is focused on a distant subject, that is, "at infinity" This definition holds true for ordinary photographic objectives and wide-angle lenses but is not applicable to telephoto lenses which may have optical nodes out in front.*

* Those interested in a more theoretical discussion should consult Neblette C. B *Photography Its Principles and Practice* Ed. 4, New York D Van Nostrand Company Inc., 6th ed 1959

While the topic is discussed farther on it is well to understand at this juncture that the so-called "normal" lens for a camera depends on the negative size As a general rule a normal lens has a focal length approximately equal to the diagonal of the film used in the camera A lens of focal length longer than normal is a "long focus" lens for the camera, one that has a shorter focal length is a "short focus" lens These terms are of course purely relative — a four inch lens is the normal objective for a 2¼ x 3¼ inch camera, yet it is a long focus lens for a 16-millimeter motion picture camera

FOCAL PLANES The focal plane for

calculate subject-lens distances. Figure 4 shows the optical relationships

Subject lens distance =

$$\left(\frac{1}{\text{magnification}} + 1\right) \times \text{focal length}$$

Magnification =

$$\frac{\text{long dimension of negative}}{\text{long dimension of subject area}}$$

(The magnification will of course be a fraction for most work, since it is the scale at which the photograph is made.)

$$\text{Focal length} = \left(\frac{\text{magnification}}{\text{magnification} + 1}\right) \times \text{subject-lens distance}$$

An easier formula to work mentally when photographing at scale sizes is as follows

Subject film distance =

$$\frac{(\text{magnification} + 1)^2 \times \text{focal length}}{\text{magnification}}$$

Notice that here the distance that is measured is the one between the patient and the *back* of the camera. The following formula can be employed in calculating the magnification obtainable with a lens of a given focal length on a camera of specific bellows extension.

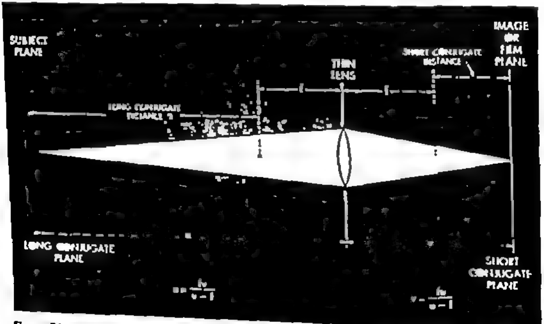


Figure IV-4: Diagram showing relationship of subject-lens and lens-film distances. Key: u = subject-lens distance v = lens-film distance, f = focal length.

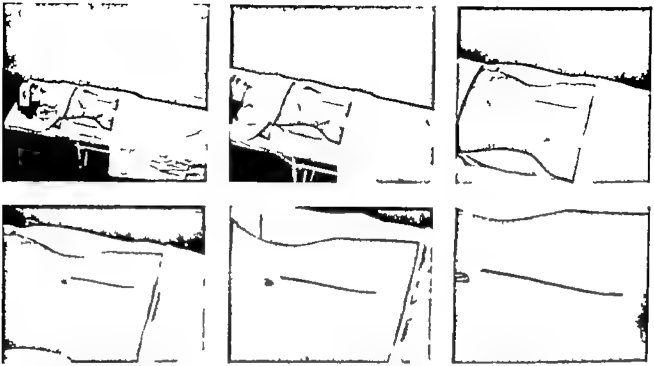


Figure IV-3: Use of interchangeable lenses in 16-millimeter cinematography of surgery This simulated setup demonstrates fields of view obtainable with Cine-Kodak Special Camera and its lenses Left to right: ⅝ 1 2 4 and 6 inch The camera was 10 feet from the patient ; the incision was five inches long; the patient s height was 60 inches

dimension of the negative· 4½ feet for a three foot field and 1½ feet for a one-foot field.

Work in "photographically cramped" quarters, such as utility rooms some radiographic exposure rooms, private offices or autopsy rooms often calls for short focus lenses (see demonstration in Figure 2) Another aspect is that the photography of patients in bed imposes limits upon the practical height at which the camera can be located above the subject

In recording surgical operations, the distance between the lens and the field must furnish ample space for the surgeon. Also the location of the camera is governed by the nature of the surgery Sometimes the subject lens distance has to be as great as that between the gallery and the table. This frequently results in an image that is too small unless a long focus lens is used The effects of using lenses of various focal lengths are demonstrated with cine lenses in Figure 3

FORMULAS The following formulas can be utilized by those who wish to

Figure IV 5: Effect of various subject-lens distances on perspective *A*, Photograph made with a 4-inch lens at 20 inches shows foreshortening—size of nose and mouth exaggerated *B* Photograph made with an eight-inch lens at 50 inches shows normal perspective. C Nose and mouth are too small with record made at 12 feet with a 14-inch lens Distance between ears is same in all three photographs. It is particularly important to consider such distortions in making records of plastic surgery

$$\text{Magnification} = \frac{\text{lens film distance} - \text{focal length}}{\text{focal length}}$$

The lens film distance can be measured from the diaphragm position to the film for practical accuracy with ordinary photographic objectives and wide-angle lenses

Effective Aperture

In using a lens at close distances it is necessary to remember the exposure correction required because of the relatively long bellows extension. The need arises because the relative apertures marked on the lens are defined on the basis of its focal length—the lens film distance for infinity focus When this distance becomes appreciably increased by extending the bellows the "effective aperture" that results is sufficiently decreased with respect to the relative aperture to affect exposure The decrease usually does not have to be taken into account until magnifications of ¼X or more are adopted In calculating exposures, the effective aperture should be treated as though it were a new relative aperture for ordinary photography

FORMULAS The following formulas may be used to calculate the effective aperture and the factor by which the exposure time should be multiplied

$$\text{Effective aperture} = \frac{\text{lens-film distance} \times \text{relative aperture}}{\text{focal length}}$$

$$\text{Time with extended bellows} = \text{time without extended bellows} \times \left(\frac{\text{lens-film distance}}{\text{focal length}}\right)^2$$

or

$$\text{Time with extended bellows} = \text{time without extended bellows} \times (\text{magnification} + 1)^2$$

Perspective

There is one main aspect of perspective with which the medical photographer needs to concern himself—the naturalness in the recorded proportions in his photograph In a subject photographed from too close a viewpoint, the parts nearest the lens appear larger in proportion to the more distant parts—the effect is called "foreshortening" On the other hand if a too-distant camera position is adopted the subject takes on an unreal, doll like, or model like appearance. This is demonstrated with the comparisons in Figure 5

DISTORTION Perspective can be a subject far beyond the scope of this book. However in connection with the medical aspects of focal length, distortion in delineation is the main concern Such distortion, provided it is not great, does not detract from the majority of medical records However when morphologic aspects are important, minimization of distortion should be taken into account The safest general rule is to make the photograph from a distance corresponding to the viewing distance for visual inspection. With a lens of short focal length, used on its regular camera, the image

Figure IV 3 Effect of various subject-lens distances on perspective A, Photograph made with a 4-inch lens at 20 inches shows foreshortening—size of nose and mouth exaggerated. B Photograph made with an eight inch lens at 50 inches, shows normal perspective C Nose and mouth are too small with record made at 12 feet with a 14-inch lens. Distance between ears is same in all three photographs. It is particularly important to consider such distortions in making records of plastic surgery

may be too small at such a focusing distance. It would then be desirable to employ a camera having a lens of longer focal length.

As a specific example, a lens of about eight inches focal length is best for studies of plastic surgery of the face. Such a lens gives a good "portrait" quality to the results and still is practical for general medical photography. It is normally used on a 5 x 7 inch camera but is also the lens of choice for smaller cameras with interchangeable lenses when records of plastic surgery are to be made.

For 35-millimeter cameras a long focus lens of 135-millimeters focal length should be considered for recording such facial views.

Parallax

The aspect of optical parallax with which the medical photographer is concerned is the difference in view of the finder and camera lens. This is caused by their separation. Since the respective optical axes are made to converge at a relatively long distance the views do not coincide at close range—the viewfinder "sees" a different field from that of the camera lens. On some precision cameras adjustable tilting close-range viewfinders enable the latter to "look down" at the camera view. Simpler cameras (unless equipped with a finder prism) require the use of focal frames or centering rods to ensure coincidence. The regular viewfinder is then not used.

Single-lens reflex cameras overcome the parallax problem by means of the internal 45-degree mirror. Though this means the camera lens also serves as the viewfinder. The mirror, which is between the lens and film, is flipped out of the way for an exposure by means of a mechanism coupled with the shutter release.

Angle of View

It is well known that a camera does not record on its film all things in front of it, even though the lens may "see" everything. The field of the camera is governed by the size of the negative. If the negative area could be illuminated like the mask opening in a slide projector, the camera lens would project a diverging beam of light. Were the beam to be focused at any distance, the *limits* of the beam would outline the field of view of the camera, at that distance.

Certain short focus lenses of special design are called "wide-angle" lenses. Their purpose is that of imaging wide fields, such as a section of a laboratory, onto the film in situations not furnishing sufficient working distance for a normal lens. A wide-angle lens has greater covering power and is used with larger films than an ordinary lens of the same focal length.

Telephoto lenses are a type of long focus objectives. Their special design, however, permits them to form images at lesser lens-film distances than ordinary lenses of equivalent focal lengths. Since they are

always used to cover a narrow angle, they do not have the covering power of ordinary lenses. For example a six-inch telephoto lens for a 16-millimeter cine camera would not be suitable for use on a 4 x 5-inch still camera, whose normal lens has a focal length of about six inches.

SPECIFICATIONS The angles of view given in a lens specification are based on the dimensions of the field for the camera focused at infinity assuming the use of a camera for which the lens was primarily designed. The greater angle lies between two lines constructed from the lens to the

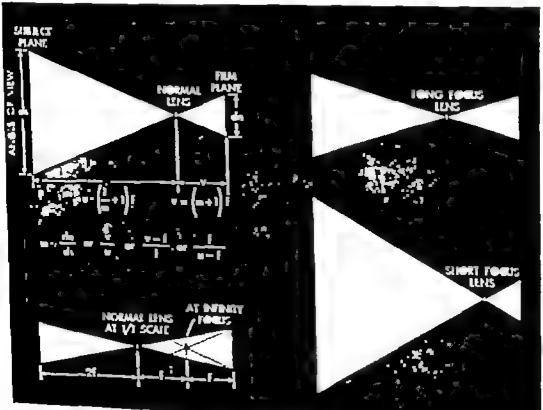


Figure IV-6 Diagram indicating changes in angle of view and magnification with lenses varying in focal length. Narrowing of angle at 1/1 scale also shown. *Key* u = subject-lens distance v = lens-film distance f = focal length, m = magnification, ds = long dimension of subject area, d = long dimension of negative.

may be too small at such a focusing distance. It would then be desirable to employ a camera having a lens of longer focal length.

As a specific example a lens of about eight inches focal length is best for studies of plastic surgery of the face Such a lens gives a good "portrait" quality to the results and still is practical for general medical photography It is normally used on a 5 x 7 inch camera but is also the lens of choice for smaller cameras with interchangeable lenses when records of plastic surgery are to be made.

For 35-millimeter cameras a long focus lens of 135-millimeters focal length should be considered for recording such facial views

Parallax

The aspect of optical parallax with which the medical photographer is concerned is the difference in view of the finder and camera lens. This is caused by their separation Since the respective optical axes are made to converge at a relatively long distance, the views do not coincide at close range—the viewfinder "sees" a different field from that of the camera lens. On some precision cameras adjustable tilting close-range viewfinders enable the latter to "look down" at the camera view Simpler cameras (unless equipped with a finder prism) require the use of focal frames or centering rods to ensure coincidence. The regular viewfinder is then not used

Single-lens reflex cameras overcome the parallax problem by means of the internal 45-degree mirror Though this means the camera lens also serves as the viewfinder The mirror which is between the lens and film is flipped out of the way for an exposure by means of a mechanism coupled with the shutter release.

Angle of View

It is well known that a camera does not record on its film all things in front of it, even though the lens may "see" everything. The field of the camera is governed by the size of the negative If the negative area could be illuminated like the mask opening in a slide projector the camera lens would project a diverging beam of light Were the beam to be focused at any distance the limits of the beam would outline the field of view of the camera, at that distance

Certain short focus lenses of special design are called "wide-angle" lenses. Their purpose is that of imaging wide fields, such as a section of a laboratory onto the film in situations not furnishing sufficient working distance for a normal lens. A wide-angle lens has greater covering power and is used with larger films than an ordinary lens of the same focal length

Telephoto lenses are a type of long focus objectives Their special design, however permits them to form images at lesser lens-film distances than ordinary lenses of equivalent focal lengths Since they are

equipment, and desires of the photographer are the governing factors in the employment of various lenses. The principles have been given here as a guide to the judicious selection of apparatus.

The photographer should keep in mind that long or short focus lenses should not be used unless there is a good reason for doing so—when in doubt, use the normal lens. For example a camera employed for general work, having a four inch lens can be utilized to make occasional records of plastic surgery However a 50-inch subject-lens distance should be maintained for good perspective and fine-grain film and developer used. The prints can then be made by enlargement. On the other hand, should equipment be needed mainly for the photography of plastic surgery it is better to get a camera with an 8-inch lens.

To obtain good perspective in photographing the eye or mouth, lenses from four to eight inches in focal length are suggested, depending on the camera. A telephoto lens of about four inches in focal length is a good general accessory for miniature cameras having interchangeable lenses. a longer one may be useful, in specific cases, for the operating room. A 10- or 12-inch lens has application in surgical photography with a 4 x 5- or 5 x 7-inch camera.

Depth of Field

Sharpness is one of the most important requirements in a medical photograph. It depends on accurate focusing, freedom from subject motion, and the phenomenon known as depth of field. If the background, subject, and foreground of most pictures are studied it will be seen that all parts of a three-dimensional scene do not photograph equally sharp As a matter of fact only one plane in the camera field can be focused sharply on the film However certain points closer to or farther from the camera than a point in the plane focused upon can be imaged sharply enough to satisfy the eye. The limits of these points cover a range called the "depth of field." This range can be adjusted to accommodate various subjects by proper settings of the camera.

It is of great practical value to know the depth-of field requirements for a given subject so that neither too much nor too little will be provided. Too much depth may call for the use of an unnecessarily long exposure time with a likelihood of subject motion. Too little would render important parts of the subject indistinct

DEPTH CONSIDERATIONS There are numerous factors governing depth of field, many of which are applied automatically by the experienced worker Those of greatest practical importance are summarized here for ready reference In outlining these points, average viewing and printing conditions had to be assumed, otherwise unusual conditions could be brought in to refute the statements. For instance, an 8 x 10-inch en-

edges of the long dimension of the field, the lesser angle covers the short dimension. They can also be drawn from the lens to the ends of the negative. Figure 8 shows these constructions In drawing them, it was necessary of course, to curtail the focusing distance for compactness. The normal angle of view (greater) for a medical camera is about 43 degrees.

Figure 6 shows how a long focus lens results in a narrow angle of view and how a short focus lens increases the angle. The narrowing of the angle by extending the bellows for 1/1 photography is also indicated, thus pointing out the role of ground glass focusing in obtaining accurate composition at close range.

Covering Power

Good lenses are optically corrected so that they provide sharp definition over the film in the cameras for which they are designed The area of good definition is a circular patch whose size indicates the covering power of the lens Not only is the definition involved, but also the brightness of the image since the intensity falls off outside the circle

Obviously the circle must be large enough to encompass the negative area, that is it must extend over the desired angle of view This angle is about the same one with which we scan a visual field comfortably without moving the head—the one an artist, with no limitation in "covering power" generally adopts for naturalness in his painting

FACTORS Covering power is a property inherent in a given lens. It does not change regardless of the camera on which the lens is used. The angle of view on the other hand, is a camera property depending on the negative size and the focal length of the lens being used. It is costly to manufacture lenses that have the covering power to produce sharp images beyond a normal angle of view Accordingly it is only the specially designed wide-angle lenses that can have a great covering power

The size of the circle of good definition increases as the focal length is increased, so that, with normal lenses the longer their focal lengths are the greater is their covering power A lens of too short a focal length cannot be expected to cover a large negative. As mentioned previously the most useful, practical rule in this respect is that the focal length of the lens should be about the same as the length of the diagonal of the negative to be covered. The covering power improves as the lens is stopped down. Therefore when employing a lens of scanty focal length (see Figure 2) to increase the angle of view a relatively small aperture should be used For infrared photography a short focus lens is inadvisable since the falling off of illumination is exaggerated in this rather contrasty technique

Practical Aspects

In these and in other considerations of the focal length of the lens the experience

ences in the size of the circles of confusion used as a basis for computation.

RANGE OF FOCAL PLANES The consideration of circles of confusion enters into the matter of photographing a two-dimensional subject (see Figure 1) only in so far as focusing is concerned. With three-dimensional subjects, however an additional factor is introduced—the depth of the subject. This is demonstrated in Figure 7 In this diagram the cones of light from five subject points at different distances from the lens are traced, and the fact that their focal planes are not at the same distance behind the lens is indicated. The focal plane of any subject point depends upon its distance from the lens—the *farther* the subject from the front of the lens, the *closer* the image to the back of the lens.

In Figure 7 it will be seen that the angle of the jaw is imaged closest to the back of the lens whereas the nose is farthest away The focal planes of the area of the temporal fossa, the eye and the chin lie between these extremes. Since the film obviously cannot be placed in all the focal planes at once, the camera must be focused so that the film coincides with the most important plane, in this instance let us say that of the eye. When this is done the film cuts the light cones coming from the other subject points in such a way as to produce circles of confusion. The possibility of photographing more than one plane in the subject sharply would seem hopeless. There is a saving

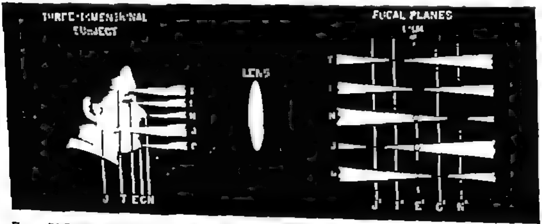


Figure IV 7: Diagram showing how five points on a 3-dimensional subject are focused in different focal planes, resulting in circles of confusion of various sizes in the film plane. The eye was focused upon and is in sharpest focus. Key- J angle of jaw; T area of temporal fossa; E, eye; C, chin; N, nose To simplify study of the diagram, the image cones have not been inverted as would be the case in an actual image.

largement *viewed* at 12 inches might show a small amount of unsharpness (because of insufficient depth of field) that would not be noticeable if the print were viewed at the more common distance of 20 inches Too an 8 x 10-inch enlargement from an entire negative and one from a fifth of the negative would show a difference in sharpness, even at the average viewing distance because of the different magnifications involved.

(1) Depth of field is governed by the size of the *tolerable* circle of confusion. There is no sudden transition from sharpness to fuzziness in the image; the circles merely get larger and larger as the image space behind or before the focal plane is traversed.

(2) The size of the tolerable circle of confusion depends upon the distance at which the prints are to be viewed. A circle of confusion in a negative is magnified, in an enlargement, to the same degree as the image, but the enlargement is usually viewed at a greater distance than the contact print. Depth-of field tables based on circles proportional to the focal length of the lens take care of this effect.

(3) For a given lens used at a given focusing distance, depth of field increases as the lens is stopped down It should be realized, however that because the resolution of lenses becomes impaired at apertures of very small *dimensions* lenses of short focal length are so constructed that they cannot be stopped down to the same f/ values as those of long focal length

(4) For a given lens used at a given *marked* aperture and for prints enlarged to the same image size, depth of field increases as the focusing distance is increased.

(5) Far depth is usually greater than near depth. However as the focusing distance is decreased or the aperture is made larger the difference tends to disappear

(6) Depth of field for some subjects can be increased by means of a swing back.

(7) For the same image size on the film (not the same distance) and the same *effective* aperture, lenses of all focal lengths have the same depth of field

(8) For the same focusing distance and *effective* aperture, the longer the focal length of the lens used the less the depth of field. For example under these conditions an 8 x 10-inch enlargement from a 2¼ x 3¼ inch negative (made with the regular lens for the camera) has more depth of field than an 8 x 10-inch contact print of exactly the same subject area.

(9) For prints enlarged to a given size, all lenses of normal angle of view with diaphragms of the same actual dimensional opening, not marked or effective apertures, provide the same depth of field. For example, a ½ inch opening is f/8 on a four inch lens and f/16 on an eight inch lens the depth of field is the same for both apertures but the four inch lens permits a shorter exposure.

(10) All lenses of a given focal length have the same depth of field for the same circle of confusion. Variations seen in depth-of field tables are due to differ

ences in the size of the circles of confusion used as a basis for computation.

RANGE OF FOCAL PLANES The consideration of circles of confusion enters into the matter of photographing a two-dimensional subject (see Figure 1) only in so far as focusing is concerned. With three-dimensional subjects, however an additional factor is introduced—the depth of the subject. This is demonstrated in Figure 7 In this diagram the cones of light from five subject points at different distances from the lens are traced, and the fact that their focal planes are not at the same distance behind the lens is indicated. The focal plane of any subject point depends upon its distance from the lens—the *farther* the subject from the front of the lens, the closer the image to the back of the lens.

In Figure 7 it will be seen that the angle of the jaw is imaged closest to the back of the lens whereas the nose is farthest away The focal planes of the area of the temporal fossa, the eye and the chin lie between these extremes. Since the film obviously cannot be placed in all the focal planes at once the camera must be focused so that the film coincides with the most important plane in this instance let us say that of the eye When this is done the film cuts the light cones coming from the other subject points in such a way as to produce circles of confusion. The possibility of photographing more than one plane in the subject sharply would seem hopeless. There is a saving

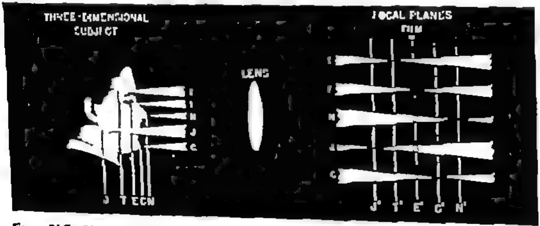


Figure IV-7: Diagram showing how five points on a 3-dimensional subject are focused in different focal planes, resulting in circles of confusion of various sizes in the film plane The eye was focused upon and is in sharpest focus. Key: J angle of jaw; T area of temporal fossa; E, eye; C, chin; N, nose. To simplify study of the diagram, the image cones have not been inverted as would be the case in an actual image.

factor however—unsharpness in a photograph is not visible to the naked eye until the fuzziness reaches a certain degree. The amount of unsharpness tolerable can be measured in terms of the size of the circle of confusion and depends mainly on the purpose of the print. For most medical records the size of the tolerable *circle of confusion is about 1/1720* of the focal length of the lens—about 1/200 inch for an 8½ inch lens, or about 1/450 inch for a 4-inch one.

The film in Figure 7 can be considered as cutting the cones from the temple and chin to form just tolerable circles of confusion. The temple and the chin are therefore just within limits of the depth of field, and will photograph sharply. On the same basis the cones from the jaw and the nose are cut to form circles of confusion that are too large to be tolerated; therefore these parts of the subject are beyond the depth of field and will photograph slightly fuzzy. Since the eye *is the object focused upon* it will be recorded sharpest.

RELATIVE APERTURES. A question that logically arises at this juncture is "Can the jaw and the nose be brought within the depth of field? They can—the depth of field can be varied by changing the size of the diaphragm opening in the lens. Why this is so can be seen by comparing the two drawings in Figure 8.

Notice the difference between the shape of the light cone produced by a wide-open lens and that produced by the same lens stopped down. In the latter instance the cone is a more slender one and any circle of confusion in a given plane is correspondingly smaller. If upper disks 2 and 3 represent just tolerable circles of confusion, then the depth of *focus* is said to be the range from 2 to 3. (The depth of *field* would be the distance between objects whose focal planes correspond to these limits in the depth of focus.) Since lower disks 1 and 4 are the same size as upper 2 and 3, stopping *down the lens has increased the depth of* focus to the range between 1 and 4. This, of course, has increased the depth of field correspondingly. Figures 9 and 10 (Plate V, page 36) show practical applications of this effect.

FOCUSING DISTANCES. *Depth of* field also depends on the lens subject distance, increasing as this distance is increased. The reason lies in the way in which the distance from the lens to focal plane (bellows draw) varies as the focusing distance is changed.

It is well known that changes in the bellows extension of a camera have to be greater when focusing at close range than at a distance. For example, with a given camera it may take 1/10-inch movement of the lens toward the film to change the *focus of the camera from an* object at three feet to one at five feet, whereas only a barely perceptible shift would be needed to change the focus from 15 to 17 feet. Yet the focusing distance is altered by two feet in each instance. If the 1/10-inch shift were made from the 15-foot position of the lens, *the focus of the*

camera would be changed to very distant objects.

These facts mean (1) that the focal planes of two objects separated by a given distance would be farther apart with a short focusing distance than they would with a long one (2) that focal planes, separated by a given spacing, contributing a given depth of focus, correspond to objects separated by greater distances as the focusing distance is increased. These have an important bearing on depth of field. The geometric principles involved are illustrated in Figure 11.

FORMULAS The following formulas will allow the photographer to calculate depth-of-field figures.

Adopting a fixed circle of confusion

Near limit of depth of field (measured from camera lens) =

$$\frac{H \times u}{H + (u - F)}$$

Far limit of depth of field (measured

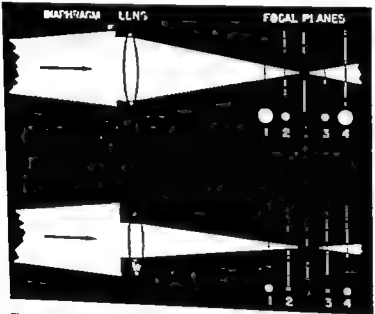
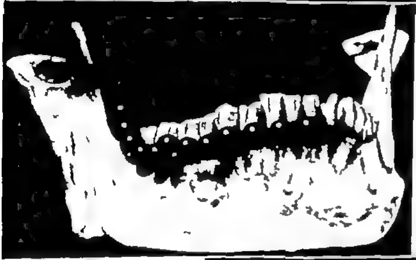


Figure IV-8 Diagram showing effect produced by stopping down lens. Upper drawing shows wide-open lens, resulting in a wide cone of light and large circles of confusion at focal planes 1 and 4 Lower drawing shows lens stopped down resulting in a narrow cone of light and corresponding reduction in size of circles of confusion Circles at lower planes 1 and 4 are as small as those of upper planes 2 and 3

A



B

C

Figure IV 9: Demonstration of depth of field effects Metal balls were glued to specimen to provide isolated points of light to show size of circles of confusion *Crossed human hairs* show tooth focused upon (arrow points to ball in same plane) Single hairs on the other teeth provide easy *detection* of ranges of depth of field *A* Marked aperture f/8; 1/1 scale Note increasing size of circles of confusion on both *sides of tooth* in focus and corresponding fuzziness of other teeth *B* Marked aperture f/45; 1/1 scale. Note that increased depth of field has equalized circles of confusion and sharpness of teeth *C* Marked aperture f/32; 1/2 scale with one quarter the exposure given the center negative enlarged 2X Notice that depth of field is similar to that of *B*

from camera lens) =

$$\frac{H \times u}{H-(u-F)}$$

F = focal length of lens

f = f-number of relative aperture

H = hyperfocal distance

u = distance for which camera is focused

d = diameter of circle of confusion

Hyperfocal distance

$$H = \frac{F^2}{f \times d}$$

Adapting a circle of confusion that is a fraction of the focal length of the lens:

Near limit of depth of field (measured from plane focused upon) $= \dfrac{u^2 \tan \theta}{L + u \tan \theta}$

Far limit of depth of field (measured from plane focused upon) $= \dfrac{u^2 \tan \theta}{L - u \tan \theta}$

u = distance focused upon

θ = angular size of circle of confusion (for critical definition, θ is two minutes

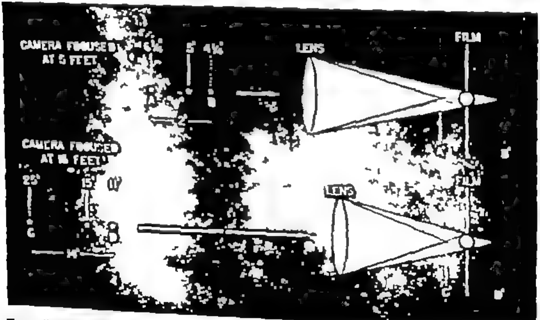


Figure IV 11 Diagram showing comparison of depth of field obtained when lens is focused at five and 15 feet respectively Cones from far points (A and C) and near points (B and D) and their corresponding circles of confusion on the film, are indicated. Primed letters mark focal planes. Notice that focal planes A and B are farther apart than C and D and yet A to B represents a depth of field of only 2 feet as compared to 14 feet for C to D

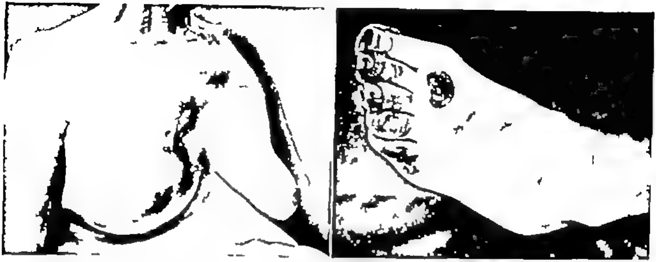


Figure IV 12: Typical depth of field problems in medical photography A Utilization of oblique viewpoint to show contours of affected and normal aspects of patient for comparison B Close up of obliquely positioned member

of arc [tan $2' = 00058$] or approxi mately F/1720)

L = effective diameter of lens $= \frac{F}{f}$

Practical Hints on Depth of Field

Some suggestions are offered here on the practical application in medical photog raphy of the factors involved in depth-of field *considerations If systematically fol* lowed the procedures become a habit and the inclination to "cross the fingers" when depth-of field problems arise gives way to self-confidence

As a first step the total depth required for the subject is estimated or measured. Then the focusing distance governed by the scale size desired, is decided upon Depth-of field tables indicators or calcu lation are next consulted to find the rela tive aperture that will yield the necessary total depth (Illumination strong enough to allow the required exposure time at that aperture must be furnished) From the figures for near and far depths the plane in the subject that should be focused upon *is selected*

Focusing is most easily done at full aper ture (with the lens "wide open") because *the bluntness of the light cone makes the* transition from sharp to fuzzy quite defi nite The adequacy of the depth of field at the final aperture can be checked on the ground glass if the image is bright enough

It often happens in medical photog raphy especially in close-up work that some juggling of factors, coupled with en larging can provide more depth of field than may seem possible at first glance For example suppose an exposure time of two

seconds is undesirably long for a 1/1 photograph and yet is required because the illumination cannot be made stronger and the lens has to be stopped down to its smallest aperture to provide sufficient depth. How can a shorter exposure be provided without decreasing the depth of field?

The answer is that a ½-second exposure can be given if the effective aperture and focusing distance are increased. This is done by photographing at 1/2 scale and setting the marked aperture one stop larger. In this way the effective aperture is increased by two stops, yet the depth of field has not been reduced, because of the greater working distance. A practical example of this principle is shown in Figure 9. Here a common depth-of-field problem in medical photography—that of recording oral conditions—is simulated. It will be noted that equivalent depth and a four times gain in shutter speed are obtainable when 1/2 scale instead of 1/1 scale is adopted. Prints of the same size were obtained, of course, by enlarging the 1/2-scale negative twice as much as the 1/1-scale negatives. A word of warning, the expedient of reducing the image size must not be carried so far that the image becomes too small on the negative. Otherwise the grain properties of the film may interfere with the sharpness in the enlargement.

When lenses of several focal lengths are available it is theoretically advisable to select the lens with the shortest focal length whenever maximum depth of field is needed. From a practical standpoint, however the advantages are greatest with lenses having focal lengths of 100 millimeters or less. This factor is useful only when enlargements, or enlarged transparencies are made and distortion must often be considered (see page 60).

When a definite scale size is adopted for the image, rather than for the finished print, it does not matter which lens is chosen, because the depth of field is the same for all—an important point when negatives for contact printing or transparencies for direct viewing are made.

Subject matter can sometimes be arranged to lie within an available depth. When barely enough depth of field can be provided under any circumstances it is better to adjust the focus in such a way that the front of the subject is favored

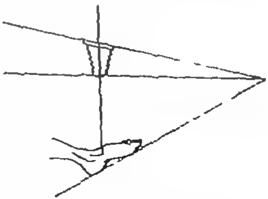


Figure IV 13: Diagram showing how to swing the camera-back for increasing depth of field.

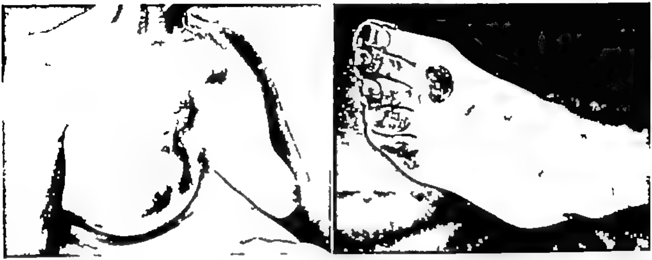


Figure IV 12 Typical depth of field problems in medical photography A Utilization of oblique viewpoint to show contours of affected and normal aspects of patient for comparison B Close-up of obliquely positioned member

of arc [tan 2 = 00058] or approximately F/1720)

L = effective diameter of lens $= \frac{F}{f}$

Practical Hints on Depth of Field

Some suggestions are offered here on the practical application in medical photography of the factors involved in depth-of field considerations. If systematically followed the procedures become a habit and the inclination to "cross the fingers" when depth-of field problems arise gives way to self-confidence

As a first step the total depth required for the subject is estimated or measured Then the focusing distance, governed by the scale size desired, is decided upon Depth-of field tables indicators or calculation are next consulted to find the relative aperture that will yield the necessary total depth (Illumination strong enough to allow the required exposure time at that aperture must be furnished) From the figures for near and far depths the plane in the subject that should be focused upon is selected

Focusing is most easily done at full aperture (with the lens "wide open") because the bluntness of the light cone makes the transition from sharp to fuzzy quite definite The adequacy of the depth of field at the final aperture can be checked on the ground glass if the image is bright enough

It often happens in medical photography especially in close-up work that some juggling of factors coupled with enlarging can provide more depth of field than may seem possible at first glance For example suppose an exposure time of two

CHAPTER V POSITIONING AND HANDLING

In arranging the subject before the camera, the distance needed to yield the desired magnification or scale has to be considered. Then it is necessary to position the patient for obtaining the correct view This should be done in a manner that provides comfort and steadiness for the patient.

To carry out these procedures the photographer must not only know the photographic technique but also how to handle his subjects patiently Another aspect is that when follow-up photographs are likely or sure it is extremely necessary to adopt uniform procedures. These should extend not only to positioning, lighting, and background but also to film, exposure and processing. In this way comparison pictures of clinical accuracy are assured.

Scale and Viewpoint

Obviously the scale should be uniform for a series of photographs depicting progressive changes. Furthermore in comparative studies of the characteristics of a disease as it appears in many patients the observer can more readily orient himself with respect to the peculiarities of the individual cases if all of the photographs are made at a definite scale

For the photography of such conditions as skin diseases, in which a widespread area is affected, at least three different scales may be required—first, a full view to indicate location and extent of pathologic areas, second, a moderately close view to show the general visual aspect of the condition third, an extreme close-up to reveal fine details.

When the correct subject film distance for a desired scale has been determined, a mark can be made on the floor to indicate the position of the camera for subsequent work at that scale presupposing, of course, a fixed subject position. Scale sizes can be determined from calculations (see Chapter IV) or else by focusing a yardstick on the

rather than the back. Slight fuzziness of details toward the background can be tolerated but prominent details in the fore ground in most instances should be sharp Obviously close and unnecessary detail in the foreground should not be included in the field of view

Quite often sufficient depth of field can be provided for the subject but not for the background. This can lead to blotchy ef fects, especially in laboratory and operat ing room scenes where it is not always possible to use a smooth background Therefore, it is desirable to eliminate a clutter from behind the subject otherwise distracting blobs of light may appear on instruments having white components or brilliant catchlights If the background objects all have about the same tone and if the illumination is kept away from them as much as possible to minimize contrasty shadows, the lack of definition in the back ground is advantageous because the sub-ject can stand out by virtue of its sharp-ness

When photographing an obliquely posi-tioned subject, such as the foot or chest (Figure 12) a swing back camera is desir able The back should be swung so that the planes of subject and film all converge off that side of the subject nearer the lens, meeting in the plane of the lens board This is demonstrated in Figure 13

cal landmarks should leave clues as to the locality of close-up regions. In general, this is easy—the neckline, shoulder axilla, nipple umbilicus, elbow knee wrist, and ankle all provide readily identifiable areas. The back presents some difficulties but the cervical prominences, the scapula and the gluteal fold help to overcome them. For extreme close-ups a fetish ought not be made out of this desideratum, however because a few words in a caption or lecture can establish the location—"lesion on the thigh, for example If the groin were included here, detail in the lesion may be photographed at too small a scale

For posture studies it is important to photograph a plumb line within or just outside the area of interest. In this way the sides of the picture can represent a true vertical and thus any body list can be detected. The plumb can be permanently attached to the ceiling and lowered when needed. Alternatively it can be hung from a movable support, see Figure 1. Fiducial grids are sometimes required for quantitative measurements on morphological studies. This can be accomplished with a background having a grid pattern of 3-inch squares. The vertical lines should be parallel to the plumb line. Some prefer the grid to appear over the body This can be achieved in printing by means of a grid scratched on a sheet of clear plastic of about the size of the negative One vertical line on this sheet is laid over the image of the plumb line on the negative Alternatively background grid lines can be manually extended across the body on the finished print.

Facial surgery or other treatment imposes the need for a pleasing "portrait" pose and lighting upon the "before" photograph so that the identically arranged "after" record can give a good impression.

The following specific posing suggestions are worth keeping in mind. Many can be implemented with a suitable chair see Figure 2.

Torso

The four positions that may be assumed for photographs of the torso or the abdomen, in order of their ease in lighting, are standing erect, sitting erect on a stool, semi-recumbent in a wheel chair and supine or laterally recumbent in bed. For photographing the anterior and lateral aspects of the thorax, either erect position is good. A standing patient can be steadied by having him grasp the back of a chair at his side

Chest

In photographing clavicular axillary and mammary regions, the sitting-erect posture is best since subject motion is relatively easy to control. To show the axilla, the arm should be raised in maximum extension, the forearm can be rested across the top of the head for comfort and steadiness. To provide best presentation of the areolar areas of ptotic breasts, the patient

ground glass and measuring its image size With cameras having no focusing back the stick can be photographed and the negative image measured

For scales of 1/1 to 1/5 it is best to measure the subject film distance each time or to scratch a fine line indicating each scale on the camera bed The reason for this is that photography at these scales requires more accuracy than is obtainable with floor marks

In arriving at a given scale during the focusing procedure the back of the camera should be placed at the correct distance from the patient the camera should then be focused by moving only the lens front When marks on the camera bed are utilized as scale indicators, the lens film distance preferably should first be set and then the whole camera and its support moved until the subject is in focus For close-up work, such as at 1/1 scale the required bellows draw should always be set and focusing done by moving the camera.

The position of the camera generally should be such as to provide a slightly high viewpoint for the photograph In examining a patient, the physician usually raises a member or he stoops, to place the area of interest just below eye level. Accordingly it is natural to adopt a camera angle that will yield about the same perspective Of course in regions such as the back a compromise has to be made because if the camera were just higher than the shoulders an excessively high viewpoint would prevail for the buttocks A position somewhat higher than the center of the region can nevertheless be adopted For the back, the base of the scapulae provides a good height for the combined thorax and abdomen, the sternum offers a suitable level.

Posing

It is desirable to obtain the cooperation of the patient so that the best position for steadiness and for adequate lighting of a specific area can be achieved The position of the patient as it affects the use of a suitable background must be considered too

Records of plastic surgery particularly must be carefully positioned for accurate comparison The surgeon should decide which anatomical plane should be generally presented to the camera The angle between the subject lens axis and the plane selected should then be determined and noted for subsequent records. In any event it is desirable for the photographer to study the planes and aspects of the entire body He can then direct the camera perpendicularly to such planes or at standardized angles to them

The basic approach to posing is to decide upon the aspect and then to arrange the patient and camera in the manner most suitable from the standpoints of comfort convenience and background Nevertheless, the photographer should be alert to other needs. Whenever possible anatomi

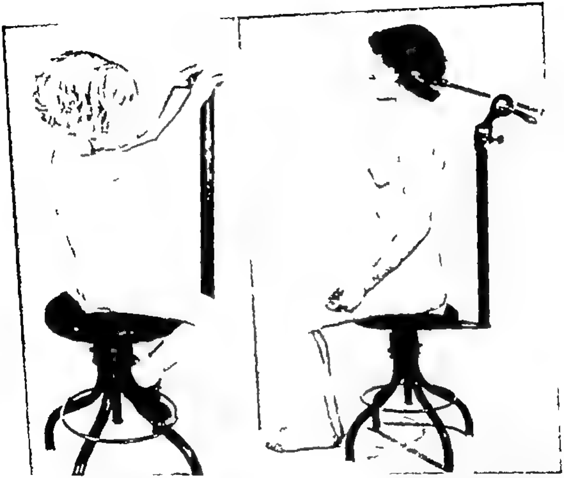


Figure V 2: To accommodate patients of many ages a revolving adjustable laboratory stool can be converted into a convenient clinical posing chair by attaching an upright tubular post as shown. Note that practically any region of the body is accessible to the camera without interference from the stool. The post can be concealed by the body or cropped off in most photographs. When it must appear it has a functional look that is not distracting. To the top of the post is attached a 5-inch, flat T-bar. This serves for attaching a padded headrest or as a handhold. Headrests can usually be obtained from dental or x ray dealers.

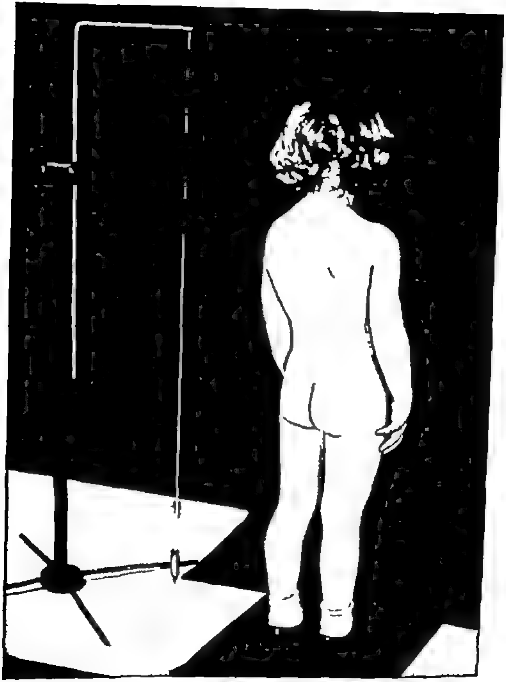


Figure V 1: A plumb line is a necessary device for posture and morphologic studies

Figure V-3 A & B A hanging banner on a dowel rod provides a background for the breasts i superior views. This can be utilized with the patient standing or sitting and covers distracting detail that would otherwise intrude. The cloth is smoother than an apron or clothes around the waist. A green-tinted surgical cloth can be used in color photography The background should be no darker than half or brighter than twice the brightness of the cloth. For clearly outlining the breasts in black-and white photography a black cloth is desirable. The background should then be kept dark to avoid a sharp line at the rod level

←

should rest both arms across the top of the head

She should take a deep breath and hold it, unless the condition at expiration is to be recorded For serial records especially inspiration or expiration should be established consistently It should also be noted that the female breast is not perpendicular to the coronal planes of the body therefore direct views of single breasts require that the patient be turned sideways to some degree in order to center the nipple on the organ

Inferior views of the breast can best be

Figure V-3 A & B: A hanging banner on a dowel rod provides a background for the breasts in superior views. This can be utilized with the patient standing or sitting and covers distracting detail that would otherwise intrude. The cloth is smoother than an apron or clothes around the waist. A grey tinted surgical cloth can be used in color photography. The background should be no darker than half or brighter than twice the brightness of the cloth. For clearly outlining the breasts in black-and white photography a black cloth is desirable. The background should then be kept dark to avoid a sharp line at the rod level.

should rest both arms across the top of the head.

She should take a deep breath and hold it, unless the condition at expiration is to be recorded. For serial records especially, inspiration or expiration should be established consistently. It should also be noted that the female breast is not perpendicular to the coronal planes of the body; therefore direct views of single breasts require that the patient be turned sideways to some degree in order to center the nipple on the organ.

Inferior views of the breast can best be

made from the foot of a bed or table bearing the patient Superior views require somewhat more preparation The patient should lean forward and place her hands behind her back or on her hips If she cannot bend over standing, she can sit down and grasp her calfs The breasts should hang just above the knees The head should be tilted upwards so as not to interfere with the camera An apron of suitable tone and suspended from a stick (after the fashion of a hanging banner) can be tied around the waist to provide a background see Figure 3

Arm

When some aspects of the upper extremity are photographed, the arm should be allowed to hang downward with the patient leaning sideways toward the member This measure prevents the side of the body from obtruding into the field of view It is sometimes necessary to steadv the arm by resting the finger tips on a firm object such as the seat of a chair (See Figure 4) Most views of the hands can be obtained by resting them on a bench covered with a background cloth

Leg

A standing position is best for all photography of the lower extremities Presenting most aspects entails no special problems in positioning the patient However the camera should not be pointed downward except for recording the instep Instead the camera should be lowered or the patient raised by having him stand on a platform or box (steadied, of course) about two feet high In photographing the medial aspect of the thigh, the most satisfactory method is to turn the patient sideways and to raise the intervening leg. The patient can be steadied quite readily if the extended foot is placed on the seat of a chair and the patient is supported from behind It is also possible for an assistant to bear the weight of the extended foot on his knee and to steady the patient by grasping both hands Figure 5 was made in this way

Should the condition of the patient preclude a standing posture for photography of the legs, a supine position is often feasible For photographing any aspect of the thigh and for the posterior aspect of the lower leg the extremity can be raised as far as possible and steadied by an assistant For photography of the lateral medial and anterior aspects of the lower leg the member need not be extended but the knee should be drawn up as far as possible in order to simplify directing the camera Injured patients usually necessitate a prone or laterally recumbent position Care should be taken to move an uninjured member out of the field if possible Plantar views of the foot can be made with the patient prone or supine the former presenting less background problems Sandbags are quite helpful in immobilizing the lower extremities.

Figure V-4: The upper extremity can be steadied by placing the finger tips or hand on the stool. The latter becomes un obtrusive against a dark background. Alternatively the seat can be covered with a cloth with a tone or color similar to the background

and with the maximum comfort for the patient

EYES

To avoid blurring, the eye must be perfectly still during the moment it is being photographed yet some eyes are so sensitive to the light that they will deviate despite the patient s every effort The apprehensive patient may be rapidly rotating the eye from one position to another and he must be closely watched until the exposure can be made during a brief moment that the eye is still One way to obtain fixity of the eye is to have the patient look at his own finger placed for him by the photographer in a position beyond or to the side of the photographic field. With the eye intently fixed on the finger while the photograph is being made the proprioceptive sense reinforces the voluntary will power The patient should always be instructed to look in the direction that causes the eyeball to rotate until the pathology is visible from the camera viewpoint and details are not obscured by the corneal reflections. (See Figure VI 9 Plate VII page 116)

If the lids must be held apart, specula should not be used because of the bright reflections from their surfaces The fingers of an assistant are best, but brightly colored nail polish should be removed so that the fingernail will not dominate the picture If it is necessary to retract the lids, cotton tipped applicators or muscle hooks can be used. Figure 6 shows an eye setup

Clinical Portraits

An aspect of clinical photography often overlooked is the provision of pleasing informal "portraits" of patients before and after treatment Yet all that is needed is an application of a few simple rules. These are equally useful in making institutional portraits of personnel and students, which is an important part of the medical photographer s work.

The "after" record is intended for demonstrating a good personal appearance usually in contrast to the poor appearance before treatment. Since many such comparisons are shown to the patient as a practice-building service the "after" record (at least) should present a pleasing personality Patients don t like the idea of unflattering shots of themselves being in the files (Figure 7) The "before" record should, therefore be planned along with the last and the needs of the final picture kept in mind so that the comparison can be valid The approach should be that of obtaining a pleasing likeness of the patient The photographer should not be deterred by the exacting requirements of professional portraiture for this is not his aim The portrait photographer uses lenses of relatively long focal length and this avoids the facial distortion from foreshortening that occurs at close subject lens distances with lenses of short focal length The pho-

tographer for a plastic surgeon does not make the same efforts in this respect, but he usually adopts a standard subject lens distance of 50 inches for a "natural" perspective. Such a distance however is not always practical for miniature color slides. At 50 inches, the average miniature camera accepts in its field of view more than half the length of a patient. To permit smaller fields at relatively great distances, long focus lenses have been provided for the more versatile miniature cameras. Such lenses should be definitely considered, because with them a natural record, encompassing mainly the face with part of the shoulders for support, can be made. On the other hand, the 50mm lens should not be used closer than 30 inches, or distortions will become too noticeable. At this distance the portrait includes a greater area than just the head and shoulders, but the effect is more pleasing than a distorted close-up.

An exception to the latter recommendation occurs in records showing the results of treatment for acne. Here, the side of the face is photographed and foreshortening is not as noticeable. And if much more than the head and neck is depicted, the details of skin texture become lost.

Since the patient is usually fully clothed, with shoes on, it is desirable to keep traffic off the platform or base in front of the regular studio background. Therefore a small clear section can be utilized for portraiture and a matte window shade pulled down for a background. It can be hung from the ceiling or wall on a wooden support. A white one serves as the best general-purpose background—its tone can be varied by the amount of light thrown on it. For color work, there are available shades in pastel colors. Pale blue-green is a good one for this work.

When the shade is 3 feet behind the subject, it is usually possible to prevent sharp shadows of the patient from falling on it. Also a white shade located at this distance and with no extra light directed upon it will usually be of the desired tone value. The background can be made relatively darker by increasing its distance from the patient, or by moving the lights closer to the patient. It can be made lighter by utilizing a lamp for illuminating the background specifically, or by bringing it closer to the subject, or by moving the lights farther away from the patient.

In general, light hair calls for a slightly darker background than the face tones and dark hair lighter tones. Meter readings can be made to compare the brightness of background and subject, or the eye can be trained to make such comparisons. A good general rule is to light the background ½ to 2 times as brightly as the fill-in side of the lighted face to yield dark or bright contrasts, respectively.

Lighting in general will be taken up in the next chapter. But while on the subject of portraiture it seems most practical and efficient to treat this special phase of

and with the maximum comfort for the patient

EYES

To avoid blurring, the eye must be perfectly still during the moment it is being photographed yet some eyes are so sensitive to the light that they will deviate despite the patient s every effort The apprehensive patient may be rapidly rotating the eye from one position to another and he must be closely watched until the exposure can be made during a brief moment that the eye is still One way to obtain fixity of the eye is to have the patient look at his own finger placed for him by the photographer in a position beyond or to the side of the photographic field With the eye intently fixed on the finger while the photograph is being made the proprioceptive sense reinforces the voluntary will power The patient should always be instructed to look in the direction that causes the eyeball to rotate until the pathology is visible from the camera viewpoint and details are not obscured by the corneal reflections (See Figure VI 9 Plate VII page 116)

If the lids must be held apart specula should not be used because of the bright reflections from their surfaces The fingers of an assistant are best, but brightly colored nail polish should be removed so that the fingernail will not dominate the picture If it is necessary to retract the lids cotton tipped applicators or muscle hooks can be used Figure 6 shows an eye setup

Clinical Portraits

An aspect of clinical photography often overlooked is the provision of pleasing informal "portraits" of patients before and after treatment Yet all that is needed is an application of a few simple rules These are equally useful in making institutional portraits of personnel and students which is an important part of the medical photographer s work.

The "after" record is intended for demonstrating a good personal appearance, usually in contrast to the poor appearance before treatment. Since many such comparisons are shown to the patient as a practice-building service the "after" record (at least) should present a pleasing personality Patients don t like the idea of unflattering shots of themselves being in the files (Figure 7) The "before" record should, therefore be planned along with the last, and the needs of the final picture kept in mind so that the comparison can be valid. The approach should be that of *obtaining a pleasing likeness of the patient* The photographer should not be deterred by the exacting requirements of professional portraiture for this is not his aim The portrait photographer uses lenses of relatively long focal length and this avoids the facial distortion from foreshortening that occurs at close subject lens distances with lenses of short focal length The pho-

tographer for a plastic surgeon does not make the same efforts in this respect, but he usually adopts a standard subject lens distance of 50 inches for a "natural" perspective. Such a distance however is not always practical for miniature color slides. At 50 inches, the average miniature camera accepts in its field of view more than half the length of a patient. To permit smaller fields at relatively great distances, long focus lenses have been provided for the more versatile miniature cameras. Such lenses should be definitely considered, because with them a natural record, encompassing mainly the face with part of the shoulders for support, can be made. On the other hand, the 50mm lens should not be used closer than 30 inches, or distortions will become too noticeable. At this distance the portrait includes a greater area than just the head and shoulders, but the effect is more pleasing than a distorted close-up.

An exception to the latter recommendation occurs in records showing the results of treatment for acne. Here the side of the face is photographed and foreshortening is not as noticeable. And if much more than the head and neck is depicted, the details of skin texture become lost.

Since the patient is usually fully clothed, with shoes on, it is desirable to keep traffic off the platform or base in front of the regular studio background. Therefore a small clear section can be utilized for portraiture and a matte window shade pulled down for a background. It can be hung from the ceiling or wall on a wooden support. A white one serves as the best general-purpose background—its tone can be varied by the amount of light thrown on it. For color work, there are available shades in pastel colors. Pale blue-green is a good one for this work.

When the shade is 3 feet behind the subject, it is usually possible to prevent sharp shadows of the patient from falling on it. Also, a white shade located at this distance and with no extra light directed upon it will usually be of the desired tone value. The background can be made relatively darker by increasing its distance from the patient, or by moving the lights closer to the patient. It can be made lighter by utilizing a lamp for illuminating the background specifically, or by bringing it closer to the subject, or by moving the lights farther away from the patient.

In general, light hair calls for a slightly darker background than the face tones, and dark hair lighter tones. Meter readings can be made to compare the brightness of background and subject, or the eye can be trained to make such comparisons. A good general rule is to light the background ½ to 2 times as brightly as the fill-in side of the lighted face to yield dark or bright contrasts, respectively.

Lighting in general will be taken up in the next chapter. But while on the subject of portraiture it seems most practical and efficient to treat this special phase of

and with the maximum comfort for the patient.

EYES

To avoid blurring, the eye must be perfectly still during the moment it is being photographed yet some eyes are so sensitive to the light that they will deviate despite the patient's every effort The apprehensive patient may be rapidly rotating the eye from one position to another and he must be closely watched until the exposure can be made during a brief moment that the eye is still One way to obtain fixity of the eye is to have the patient look at his own finger placed for him by the photographer in a position beyond or to the side of the photographic field With the eye intently fixed on the finger while the photograph is being made the proprioceptive sense reinforces the voluntary will power The patient should always be instructed to look in the direction that causes the eyeball to rotate until the pathology is visible from the camera viewpoint and details are not obscured by the corneal reflections (See Figure VI 9 Plate VII page 116)

If the lids must be held apart specula should not be used because of the bright reflections from their surfaces The fingers of an assistant are best but brightly colored nail polish should be removed so that the fingernail will not dominate the picture If it is necessary to retract the lids, cotton tipped applicators or muscle hooks can be used Figure 6 shows an eye setup

Clinical Portraits

An aspect of clinical photography often overlooked is the provision of pleasing informal "portraits" of patients before and after treatment Yet all that is needed is an application of a few simple rules. These are equally useful in making institutional portraits of personnel and students, which is an important part of the medical photographer's work.

The "after" record is intended for demonstrating a good personal appearance usually in contrast to the poor appearance before treatment Since many such comparisons are shown *to the patient* as a practice-building service the "after" record (at least) should present a pleasing personality Patients don't like the idea of unflattering shots of themselves being in the files (Figure 7) The "before" record should, therefore be planned along with the last, and the needs of the final picture kept in mind so that the comparison can be valid The approach should be that of obtaining a pleasing likeness of the patient The photographer should not be deterred by the exacting requirements of professional portraiture for this is not his aim The portrait photographer uses lenses of relatively long focal length and this avoids the facial distortion from foreshortening that occurs at close subject lens distances with lenses of short focal length The pho-




Figure V 7: Flatly lit full face records are often used to demonstrate the technical results How ever a more informal portrait is also suited for showing the changes Following a few simple procedures in posing and lighting makes the difference between an unflattering record and one that is in keeping with the improvement in personal appearance produced by the treatment

clinical work as one unit Lighting equipment need not be elaborate That already in use will suffice. Two lamps on stands would probably cover most needs How ever a background light in addition would permit more versatile effects Posing and lighting have to be considered together Even the most classical screen beauty has imperfections in her features that tax the alertness of the cinematographer We all have such defects However the common expression "but he (or she) grows on you" indicates how the personality can prevail over first impression geometric im →

Figure V-8: To find a pleasing angle of view the patient is asked to assume the four poses shown here Sometimes a good intermediate pose will be noticed during the procedure Flat lighting is adopted at this stage see Chapter VI

attitudes in succession, glancing toward the camera (with the eyes alone) in each one (Figure 8) The face should be directed slightly upward to the right, slightly downward to the right, slightly upward to the left, and slightly downward to the left. The shoulders move right or left with the head.

A direction for the main light is found with a single lamp after the pose for the head is determined. It should be directed from about 45 degrees to the camera axis to light more strongly either the far side or near side of the face whichever is more pleasing (Figure 9)

The main light is a few inches or more above eye level, and this amount should be varied with the subject.

A fill-in light is aimed along the camera axis. Its illumination should be one half that of the main light for color work, and one quarter for black-and white records.

Sufficient prominence for the clinical condition is studied as the pose and lighting are varied. A slight smile is usually desirable Multiple flash equipment permits most of the lighting niceties of flood-lighting However the benefits of a simple flash unit are lost through such elaborations The photographer who uses single photoflash units or electronic flash equipment without a modeling light will not be able to arrange and study his lighting.

Nevertheless, he can at least benefit by the posing suggestions in the foregoing. Also, he can sometimes detach his flash unit from the camera and let it serve as a modeling main light by holding it 20 inches or so to the side of the camera A light-toned wall can then serve as a source of reflected fill-in illumination

The direction and height of such a unit will have to be judged from experience Watching the effect of office or window light on the patient will often suggest the side on which to place the lamp. Then the height can be estimated from the character of the patient's eyes. Deep-set eyes should be lighted at slightly above eye level, whereas prominent eyes will benefit by raising the lamp To minimize plumpness the light should be on the side of the camera that is directly opposite the near side of the face For example if the patient is turned toward the photographer's right, the unit should be on his left. The converse is true for rather thin faces.

Handling Patients

The photographer should remember that in posing all patients for photographs of any region of the body a kindly courteous approach is imperative Many patients have been made uncomfortable embarrassed, or hostile, simply because the photographer acted that way Photography should be presented as a natural and necessary adjunct to a medical examination. A good, friendly but not intimate professional manner is just as important to the photographer as it is to the physician.

The photographer should appear sym-

Figure V 9: The main light should be tried on the far and near sides of the face to determine the best location and lighting angle for flattering the patient

perfections The cold mechanism of the camera, however is unmoved by personality—its image is always a first impression Therefore it is up to the photographer to so pose and light his subject that a true and pleasant personality is presented to the literal eye of the camera.

The expert portrait photographer is a real artist in this respect and his measures become an undefinable second nature Nevertheless a few simple suggestions will help those who merely aspire to making their records pleasing They should not be regarded as rigid rules but as guides

The camera is at the height of the mouth of the subject

A "three-quarter" view (Figure 7 right) is usually most pleasing.

The bridge of the nose lies about one third of the way down from the top of the picture

There is more space ahead of the subject than behind the head.

A pleasing pose for the head is usually found by having the patient assume four

Many hospital procedures are uncomfortable. Photography provided the heat problem is controlled (see Chapter VI) seldom is. However some attendant procedures of posing, such as moving a painful limb or exposing a lesion may be painful. Kindliness is needed here, but the patient should never be told that he won t be hurt when there is a possibility of discomfort. Rather he should be assured that he will be kept as comfortable as possible.

In photographing children, the words won't hurt have spoiled more photographs than has faulty technique The child then "knows" he will be—especially if his mother uses them It is a good policy to let the mother accompany the child to the department, but she should be kept out of the studio whenever possible. If present, in the studio, she should be seated in a far corner and asked to hold the child's clothes in her lap. This will usually keep her seated.

There is no sure way of handling needle shy youngsters. Sometimes the photographer can doff his white coat and thus momentarily eschew his paramedical connections for the child's reassurance. All children are apprehensive at first. The session can well be made into a game. The magic word turn is often effective the child likes to take his turn at being photographed. Peek a-boo around the camera usually calms little ones. A ride on a revolving stool sometimes works wonders Since flash techniques are best for children technically they can often be captivated with fanciful descriptions of the light they are going to see.

Most children like to be told they are big enough to help adults. Therefore they can be asked to do so rather than commanded to behave. The child can be requested to hold a film holder for example-it will be more intriguing than a common toy They should not be handed a small object that can be swallowed, and the film holder had better be an old one in case the patient should happen to be a budding horseshoe champion. A toy does help in many cases and a mock photograph can be made of it. Bribing children with lollipops is unwise, especially if a patient should turn out to be diabetic. A child in a tantrum should be left alone and ignored if all those in the studio rush over to calm him, signal strength will go up about 10 db

A struggling child will usually supersede himself in acrobatics if held. It is better to leave him alone in front of the camera—with a nurse alert to a possible fall. Then there are often moments when the patient is in a relatively good position The best record that can be quickly made under the circumstances is exposed without insistence on perfection. The child can be told "that is all there is to it." Quite likely he will become calmer Then a better shot can be tried—with or without better cooperation. Should the first photograph make matters worse the second can be foregone

pathetic and the best way to do this is to actually feel sympathetic. He should nevertheless impart an impression of being busy and efficient This and the avoidance of leading questions like "How do you feel?" will be some safeguard against un corking a flood of details about the most unique case in medical history

Chat can well be about lighting and positioning the patient so that a clear photograph can be made for serving the pa tient s best interests But negative statements such as "You are not holding your arm high enough" must be guarded against The photographer should remem ber that he is making the picture the pa tient is not He can say "Now I'll need that arm higher up for a good view" One locution that is sickening to intelligent pa tients and to most children is the use of the impersonal "we" Use the patient s name or call a small boy "muscles" and a girl "honey"

Avoid discussing the clinical aspects of the condition and be careful in referring to it Terms like "lesion" or "swelling" are relatively safe. But never call a radiation reaction a "burn" Again it is better to speak about the anatomic entity when positioning than to remind the patient that he has a scar The photographer can well keep his ears tuned to the phraseology used by the physicians in talking to pa tients

The posing procedure should be as short as possible Films cameras accessories and lights for a shot ought to be ready before the patient is asked to disrobe and go over to the background. The lighting arrangement can usually be roughly esti mated as soon as the area of interest is noted at the reception desk or on the request slip A measurement made from the subject to the floor with the patient stand ing or sitting in the waiting area, will guide the approximate placement of the camera and establish the height of the lamps in standard plans

Requests should be made *to* the patient, not *of* him The photographer should adopt an air of assuming that the patient is perfectly willing to be photographed An embarrassed or apologetic demeanor will only turn a possible reluctance into a definite objection

The photographer should be in charge, with medical or nursing assistants fading into the other end of the studio The former may be called upon to check the viewpoint or to adjust an instrument or apply a retractor The latter may be needed with a hysterical or truculent pa tient, and they should be the regular at tendants who understand the handling of the particular individual They are also required in helping weak patients attending to and advising on asepsis or in removing dressings and cleaning lesions When mu cosa has to be handled, the assistants are the logical ones to do it because the photographer cannot be expected to have clean surgical gloves handy

Many hospital procedures are uncomfortable. Photography provided the heat problem is controlled (see Chapter VI) seldom is. However some attendant procedures of posing, such as moving a painful limb or exposing a lesion may be painful. Kindliness is needed here, but the patient should never be told that he won t be hurt when there is a possibility of discomfort. Rather he should be assured that he will be kept as comfortable as possible.

In photographing children, the words won t hurt have spoiled more photographs than has faulty technique The child then "knows" he will be—especially if his mother uses them. It is a good policy to let the mother accompany the child to the department, but she should be kept out of the studio whenever possible. If present, in the studio, she should be seated in a far corner and asked to hold the child's clothes in her lap This will usually keep her seated.

There is no sure way of handling needle-shy youngsters. Sometimes the photographer can doff his white coat and thus momentarily eschew his paramedical connections for the child's reassurance. All children are apprehensive at first. The session can well be made into a game. The magic word turn" is often effective the child likes to take his turn at being photographed Peek-a-boo around the camera usually calms little ones A ride on a revolving stool sometimes works wonders. Since flash techniques are best for children technically they can often be captivated with fanciful descriptions of the light they are going to see.

Most children like to be told they are big enough to help adults. Therefore they can be asked to do so rather than commanded to behave. The child can be requested to hold a film holder for example· it will be more intriguing than a common toy They should not be handed a small object that can be swallowed and the film holder had better be an old one in case the patient should happen to be a budding horseshoe champion. A toy does help in many cases and a mock photograph can be made of it. Bribing children with lollipops is unwise, especially if a patient should turn out to be diabetic. A child in a tantrum should be left alone and ignored If all those in the studio rush over to calm him signal strength will go up about 10 db

A struggling child will usually supersede himself in acrobatics if held. It is better to leave him alone in front of the camera—with a nurse alert to a possible fall. Then there are often moments when the patient is in a relatively good position The best record that can be quickly made under the circumstances is exposed without insistence on perfection. The child can be told "that is all there is to it." Quite likely he will become calmer Then a better shot can be tried—with or without better cooperation Should the first photograph make matters worse the second can be foregone

pathetic and the best way to do this is to actually feel sympathetic. He should nevertheless impart an impression of being busy and efficient This and the avoidance of leading questions like "How do you feel?" will be some safeguard against un corking a flood of details about the most unique case in medical history

Chat can well be about lighting and positioning the patient so that a clear photograph can be made for serving the pa tient's best interests But negative statements such as "You are not holding your arm high enough" must be guarded against The photographer should remem ber that he is making the picture the pa tient is not He can say "Now I'll need that arm higher up for a good view" One locution that is sickening to intelligent pa tients and to most children, is the use of the impersonal "we" Use the patient's name or call a small boy "muscles" and a girl "honey"

Avoid discussing the clinical aspects of the condition and be careful in referring to it Terms like "lesion" or "swelling" are relatively safe. But never call a radiation reaction a "burn" Again it is better to speak about the anatomic entity when positioning than to remind the patient that he has a scar The photographer can well keep his ears tuned to the phraseology used by the physicians in talking to pa tients

The posing procedure should be as short as possible Films, cameras, accessories and lights for a shot ought to be ready before the patient is asked to disrobe and go over to the background The lighting arrangement can usually be roughly esti mated as soon as the area of interest is noted at the reception desk or on the request slip A measurement made from the subject to the floor with the patient standing or sitting in the waiting area, will guide the approximate placement of the camera and establish the height of the lamps in standard plans

Requests should be made *to* the patient, *not of him* The photographer should adopt an air of assuming that the patient is perfectly willing to be photographed An embarrassed or apologetic demeanor will only turn a possible reluctance into a definite objection

The photographer should be in charge with medical or nursing assistants fading into the other end of the studio The former may be called upon to check the viewpoint or to adjust an instrument or apply a retractor The latter may be needed with a hysterical or truculent pa tient and they should be the regular at tendants who understand the handling of the particular individual They are also required in helping weak patients attending to and advising on asepsis or in removing dressings and cleaning lesions When mu cosa has to be handled, the assistants are the logical ones to do it because the photographer cannot be expected to have clean surgical gloves handy

extreme. Noisy frivolity and familiarity are as out of place as nonchalance, indifference and surliness. For the clinical photographer, patience is as indispensable as patients. If he does not possess the former he is out of place handling the latter.

Releases

The concepts of privacy and contract as they relate to clinical photography are subject to differing interpretations in various countries and states. In general, clinical photographs should not be made without a permission of some kind. Even when a part of the body is photographed that does not reveal the identity of the patient, the right to privacy is involved.

The patient's consent, or that of a parent or guardian, should be obtained and constitutes a valid contract. Misunderstanding is least likely to arise when such permission is given in writing. Therefore it is most advisable to have a printed release worked out by a local legal authority.

The form should be short and couched in simple lay language, because many people are wary of signing legal-looking statements they cannot understand. It is reassuring to have incorporated a sentence stating that the patient's name will not be revealed when the photograph is used. It should also be made clear that the photograph is made for medical purposes only.

Serial Records

Reproducibility is the keynote of making serial records, otherwise they do not provide valid qualitative or quantitative comparisons. A minor but sometimes important consideration is the size change that may occur in the area of interest. Treatment, such as radiation, may involve a larger area than the original lesion. Or an extensive flap may be raised in plastic surgery; the donor area should be included in the first record of the procedures. In other cases, a lesion may be expected to extend its margins.

For reproducibility in viewpoint, scale and modeling, a careful record of patient, camera and light positions is imperative. Figure 10 shows the form employed by the author. It is based on those commonly used by medical photographers. When standard lighting plans are suitable, the technical part of the record need not be as detailed. A check with previously made photographs should always be made.

Another help to serial study is the indication of anatomic landmarks. This can be done by marking the skin with a soft wax pencil or skin-marking crayon. (Lipstick is usually too difficult to remove and will stain clothing.) The wax can be washed off readily with rubbing alcohol. Figure 11 shows a typical marking. These indications, when accurately placed after careful palpation, can photographically depict a condition that does not clearly appear superficially, even to the eye. They offer an excellent way to follow changes in such conditions.

Intellectual honesty demands that "before" and "after" records be made under

In photographing any patient, the photographer should exude confidence He ought never give the impression of experimenting on the patient or of learning photography The apprentice had better practice on his colleagues or models Then as he gains experience arrangements might be made to engage a long term ambulatory patient in the hospital as a model Such individuals often welcome a change in the tedium and are quite co-operative This is especially true of patients from the pediatric ward who are not very ill Of course they should not be tired

In most hospitals it is not the photographer s responsibility to get the patients to and from his department But he should know the rules involved and abide by them He should also feel responsible for the patients welfare when they are in his department

The photographer must be constantly on guard against accidents. Equipment must be in good condition a hot lamp must not fall on the patient because of a rickety standard Sometimes a patient who has been in bed for some time and who is taken to the department in a wheel-chair may become dizzy and fall when first asked to stand. Children must be watched for a sudden dart toward some piece of apparatus that might hurt them The unforeseen may happen For example when the author was making the demonstrations for Figure VI-5 page 109 the patient sat on a cane-bottom chair while lights were being changed Fortunately this was noticed almost at once nevertheless, a wait of one half hour ensued to prevent a most unusual gluteal lesion from appearing in the literature

The photographer should also be on guard against slipping into personal habits that can slowly curdle his own outlook and quickly sour the patients attitudes Hectic days can become quite trying so that forbearance toward a sick person sometimes has to be consciously adopted rather than sympathetically felt It should be remembered that a patient does not know about the day s happenings and cannot be expected to make allowances for them

A patient should not be resented as a disruption of departmental work—photographing him *is* the work of the department He should not be made to feel like a peasant in a soup line by inconsiderately being kept waiting and ignored for long periods When there has to be a delay it should be explained pleasantly and interesting reading or picture material offered

Regardless of how difficult it may be at times, calmness and tidiness should pervade the studio Patients are people in trouble or discomfort The only purpose of the medical institution is to alleviate this not aggravate it Therefore the photographer s vicissitudes have to be kept to himself Doing this has a practical value too it will result in better cooperation from the patient In that way the photographer s own troubles are not aggravated

Of course cheerfulness (natural or forced) should not be carried to the other

Figure V 10- A. Form to keep technical records for reproducibility and for studying reliable lighting methods. The data apply to the optimum photograph in B

PHOTOGRAPHIC RECORD

Medical Division Eastman Kodak Company

* * *

Dr s No A 7 Hospital No — Kodak No P 12 L

Patient s Name: C T

Doctor s Name: W E

Hospital: —

Patient Data:

Male	Fem	Age	Race
✓		15	W

Photographic Sessions:

1st	2d	3d	4th
a	7/15/53		

RELEASE FOR PUBLICATION:

Needed ☐ Obtained Yes ☐ No ☐

CONDITION REPRESENTED: Splaying of lower rib margins

ANATOMIC REGION:

Full Length ☐ Front ☑

Back ☑

Trunk ☑ Side ☑ and 3/4

Extremity ________

Face ☐ Close Up ☐

Describe region for Closeups or Face:

Photographer HLG

Rendering:

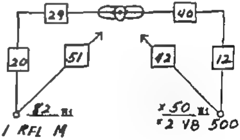
Sizes	Pan	Pan 66	Ortho	I-red	Color
5X7	SPB				

Camera 2 DV Lens 8 - f/16 1/2 sec.

Subject Lens Dist 65" Lens Height 45

LIGHTING Main f c 10

Fill f c 5



NOTES: Sternum at 45

Posture for body or extremity: Standing erect, full inspiration

Features to be brought out: shape of rib cage a general almness

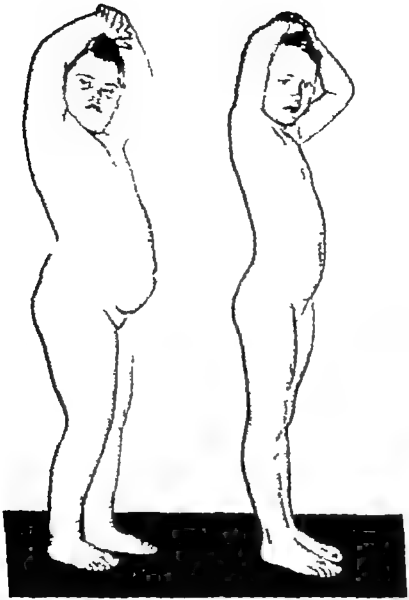


Figure V 12: In following th progress of patients over a period of time serial comparisons are xtremely useful Considerations for making instructive records are given in the text

identical conditions For example it would be easy to "prove" an improvement in acne by utilizing a texture lighting for the first record and a soft lighting for the last This is seldom done deliberately but the photographer should guard against doing it unthinkingly

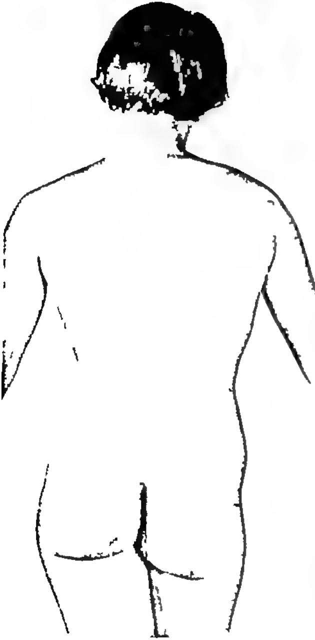


Figure V 11: Anatomical landmarks help to show changes that are mainly subcutaneous They can be indicated with a soft wax crayon

Photographic Comparisons

An efficient way to describe an abnormal condition is to compare it with the normal. It is then easier for those unfamiliar with the subject to grasp the appearance of the abnormality This is quicker than learning to visualize the disassociated pathologic entity Since photography is such an excellent aid to description it is most appropriate to use it for this purpose Not only is the presentation simplified but also the comparison is freely made

Any of the techniques described in this book can be employed—Figure 12 was made with a simplified setup The major factor for a successful comparison whether single or serial is the careful juxtaposition of a valid norm and the patient For instance the two girls are the same age and are posed alike and in such a position that the main anatomic differences can be seen readily Male and female patients should seldom be compared, and this is rarely done with adults because of obvious differences in physique Yet comparisons are quite often made between boys and girls This is undesirable because there is always the possibility of doubt in the mind of the

←

Figure V 12C

comparing small anatomic regions Generally similar areas should be selected, but this is not always possible It might be argued that two right feet should have been presented in Figure 12. However a moment's reflection will reveal the rather difficult posing problem particularly since both subjects were very young and one was not co-operative

The major benefit of the simplified technique is that lengthy preparation and arrangement are eliminated. Hence, with it, children, whose attention span may not tolerate more formal photography can be easily photographed. Also, because two subjects whether young or old, have to be posed, the photographer will not want to be concerned with too many technical details. He can better concentrate on the factors discussed above which lead to

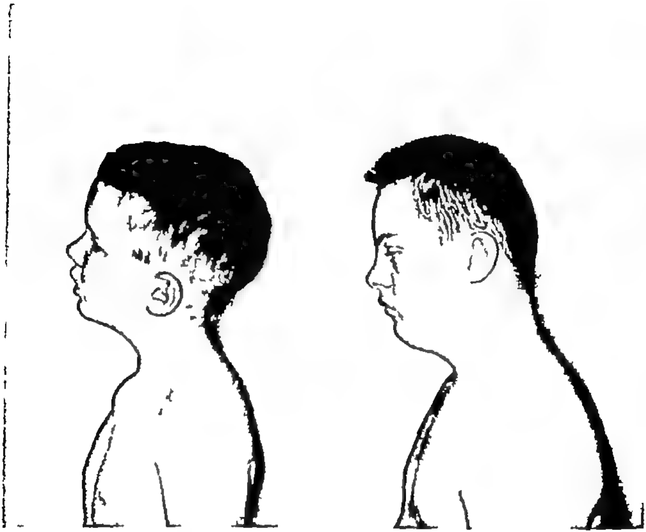


Figure V 12B

viewer as to whether all the differences that appear are really due to the particular condition Of course, when variations involving sex are to be studied, such a comparison would be necessary

Sometimes a little extra thought can lead to records that supply more information than the mere physical comparison For the record of the two boys a nurse engaged them in conversation In this way the significant apathy of the boy on the right could be contrasted with the alertness of the one on the left

Closeups are particularly suitable for

CHAPTER VI LIGHTING

SIMPLIFIED lighting has been discussed in Chapter III. It is entirely satisfactory for those for whom it is not practical to go any further in proficiency For a complete photographic program, however it is necessary to extend the knowledge gained in applying the simple technique. Accordingly this chapter first presents standardized lighting as a next step. Upon the considerations thus established it is possible to develop the factors leading to optimum lighting for any situation.

Standardized Plans

The most practical approach for a beginner is that he adopt standardized lighting plans. These, when associated with exposure tables (see Chapter VII) offer good lighting and correct exposure. They also provide a basis for variations to suit individual cases when proficiency is gained.

Another important advantage is that patients debilitated by lying in bed need not be subjected to lengthy photographic preparations—the height and distance for the camera can first be measured and the patient can then sit down while camera and lights are being arranged (a final check on focus and composition need not take long) Figure 1 shows the three most useful set ups. Placement of lights and subject may be facilitated by marking the positions on the floor with adhesive tape.

Plan I This arrangement of equipment is suitable for photographing areas such as the head and shoulders, portions of the face and regions of pathology on the limbs and torso The lighting is unbalanced sufficiently to yield good topographic delineation. When more relief is required, such as in photographing lesions with marked texture, the light nearer the patient can be moved farther to the side to provide a more oblique illumination Figure 2 shows the type of subject for which Plan I is intended.

Plan II This arrangement is especially designed for photography of the entire figure. Since the lighting produces balanced modeling, it is particularly suited to posture work, wherein it is important not

really informative comparisons And when these records are to be made serially he will not want to be obliged to recreate an elaborate lighting setup each time

On those occasions when optimum lighting of the patient is imperative this should be established first The patient can then rest while similar main lighting is arranged for the normal subject The fill in light should be bright and placed at a relatively long distance from the subjects it will then serve for both

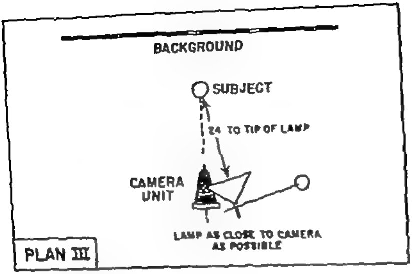
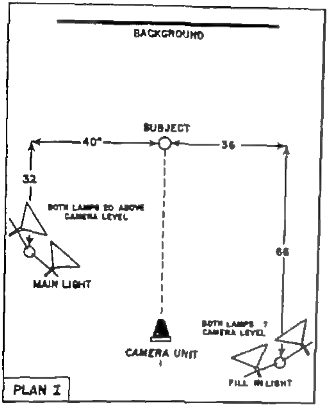


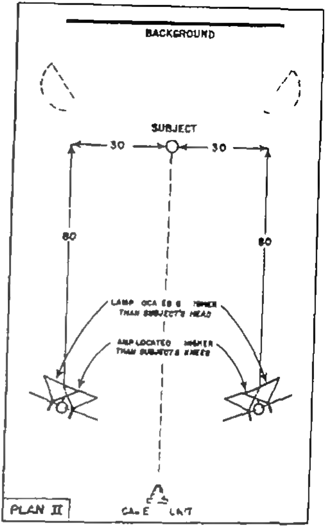
Figure VI-1 Useful standard lighting plans for clinical photography. The dotted lights in Plan II are optional and serve to eliminate or minimize shadows.

←

should be used in posture-study photographs, it is sometimes advisable with patients having very dark hair to suspend another lamp over the head to provide additional light for the hair and thus to outline the contour of the head against the dark background. This supplementary lamp, shielded from the camera lens by a reflector should be located at least three feet above the patient and preferably about one foot nearer the background. By placing the lamp between the patient and the background, very little light falls on the camera aspect, and the exposure recommended for this plan is not materially affected.

Plan III This arrangement provides lighting for extreme close-up. It is especially useful for such subjects as views of the outer ear the labial aspects of the teeth, the interior of the mouth. There is only one light source and thus only one shadow The arrangement makes a reasonably good rendition of fine texture such as the pores of the skin, when the general aspects of the area are important. However a photograph for recording texture alone requires a different treatment, as explained in the section on *Lighting Principles* to follow The lamp should be placed as close to the camera-subject axis as possible- however care should be observed that the shadow

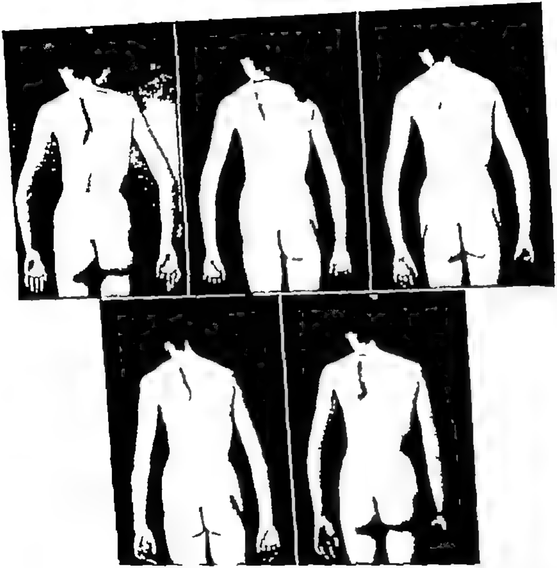




to create false impressions by the introduction of asymmetrical shadows

In employing this plan, each pair of lamps and reflectors should be arranged in vertical alignment, Figure 3 and directed to provide even illumination over the entire figure. This can be accomplished by turning the lamps on singly and noting the position of the illumination spot of greatest intensity The two lower lamps should be directed toward a point a few inches above the knees of the patient The two upper lamps should be directed toward the chest of an adult or toward the forehead of a child It is usually best to locate the camera at a height about two-thirds that of the patient.

Since a black or dark gray background



notice how the left arm has cast a shadow on the left hip and thus given a false impression of the body outline. A spotlight on the hair was used for some of the photographs to show how this separates dark heads from the background.

←

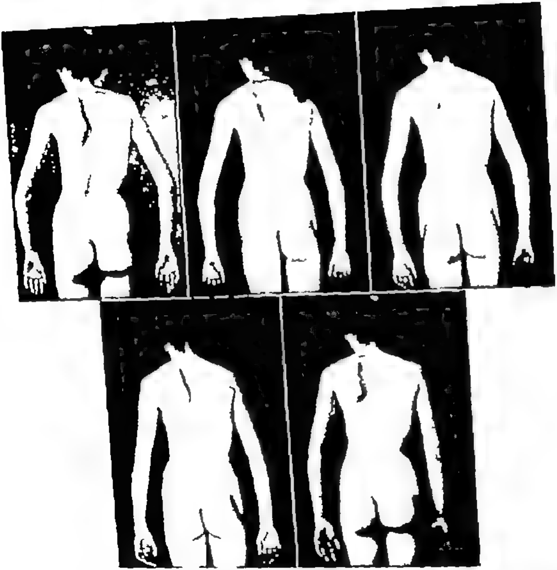
for this is that photographic films particularly color materials, do not have the ability (referring to the final print or transparency) to reproduce as great a subject brightness range as the human eye can perceive Therefore the depth of the shadows has to be reduced

Figure VI-4 Type of subject for which Plan III is suited; example is actual size reproduction of 1/1 scale photograph (2¼ x 3¼ film) of ear to depict effect of x ray therapy

The fill-in illumination must not be as strong as the key lighting or the modeling will be destroyed For black-and white films the fill in intensity should be about ½ of the key intensity This ratio should be made about ¼ for color films The fill in light should also be placed as close to the camera axis as possible Otherwise a lighting results which produces confusing double shadows Occasionally as in the torso record cited above two fill-in lights are required to provide an even, all-over illumination that allows a key light to provide symmetrical directional lighting. The effects of various lightings are shown in Figure 5

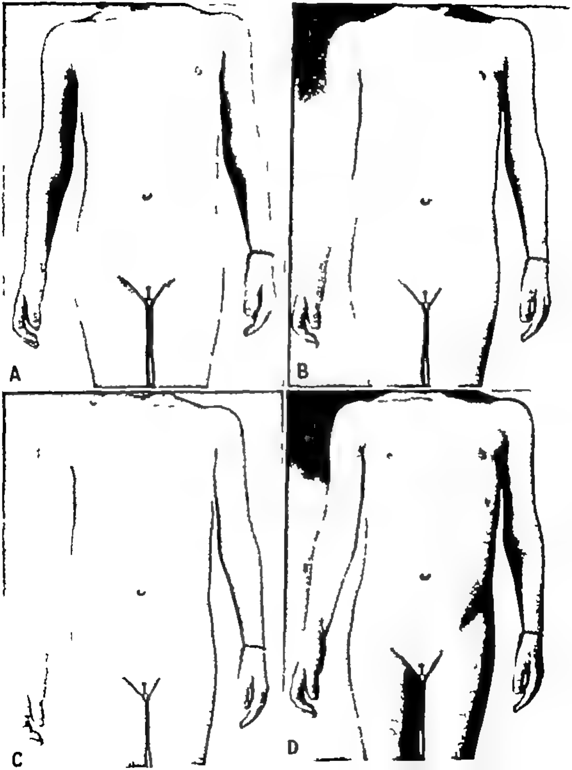
The intensity of illumination can be reduced by changing the type or number of lamps or by changing lamp-subject distances The intensity with respect to distance behaves according to the "inverse square" law (to a close enough approximation for photography) That is to say the →

Figure VI-5: These illustrations show the basic principles of optimum lighting (left to right) *A* The key light was arranged to the left and about two feet above the height of the patient's head to produce the desired modeling The fill in light was ¼ of the intensity of the key light and was placed directly over the camera subject axis Notice how both the dark and light sides of the patient are contrasted against the medium grey background *B* Too much fill-in illumination; notice how the modeling has been reduced and the condition minimized *C* Flat lighting from three lights distributed on each side of the axis; note how the lack of modeling has further obliterated the condition *D* Bizarre lighting from below; such effects are sometimes necessary but generally the key light should be above the camera so that natural overhead lighting can be simulated *E* The photographic conditions here are the same as for *A* but



notice how the left arm has cast a shadow on the left hip and thus given a false impression of the body outline. A spotlight on the hair was used for some of the photographs to show how this separates dark heads from the background.

←


A
B
C
D

ratio of intensities varies as the inverse ratio of the distances squared. Thus, if a lamp is moved back to twice its former distance the intensity is reduced to ¼ *not* to ½. By having one lamp at 1.4 times the distance of a similar one the intensity from the farther lamp is ½ that from the closer one.

The use of two lamps in a given position instead of one, however, doubles the intensity. The No. 2 photoflood lamp also has twice the intensity of the No. 1 photoflood lamp.

These two lights—key and fill-in—form the basic lighting arrangement. Any further lights are introduced for specific purposes. For example, a light can be used to illuminate the background. This gives the photographer an opportunity to vary the background tone and to minimize shadows. Again a "back light" can be used to separate the subject from the background. Such a light is placed behind the patient, either hidden from the camera by his body or else outside the camera field. It illuminates and emphasizes the edges of the subject. Sometimes a spotlight can be used as a glancing light to provide a little extra illumination on a protruding part of the subject. As a general rule, a bright area of the subject will appear to "stand out" more than the darker areas. For example a cup-shaped lesion or a depression can most realistically be recorded if the edges

←

Figure VI-6: This illustration demonstrates the difference between lighting contrast and printing contrast. Left to right, in *A* is shown a panchromatic film rendering of the extremely flat lighting required for an infrared study of the abdomen of this patient with nephritis. The negative was developed normally and was printed on a No. 2 paper. Notice that only the abdomen is flatly lighted; the arms and shoulders show evidences of shadows, caused by the fact that neither of the lights cast much illumination into these regions. For *B* the lighting was unbalanced sufficiently to give more roundness to the abdomen. This was also printed on a No. 2 paper and the result is a good representation of the visual appearance. The C version was printed on No. 4 paper from the *B* negative. Notice that the abdomen appears flatly lighted as in *A*. However, there are no good blacks in the print and a spurious lack of shadows, particularly on the arms. Finally *D* shows a print from the *B* negative on No. 4 paper and the exaggerated contrast presents a harsh effect in the middle tones that would not be present in a normal print made from another negative exposed to a more contrasty lighting. The spurious degree of roundness in D is undesirable from a clinical as well as a photographic standpoint because the appearance of the patient thereby suggests nephrosis, a condition with which this case was being compared.

It is also valuable to realize that the A negative could not be "corrected" by printing it on a more contrasty paper. This would only make the blacks more intense and the abdomen would still be flatly modeled. On the other hand, a too slightly modeled abdomen (say at 1½:1) could be improved in printing, but the shadows would go unnaturally dark. The result might be a saving compromise as a record of the abdomen but would not be as good in all respects as a correctly lighted photograph.

of the cup are brightly lit. A dome shaped lesion, on the other hand usually has a highlight near its apex and thus needs no supplementary lighting

Another good point to remember is one that helps to tonally separate the patient from the background When lights are *closer to the patient than the camera, or* are at the camera, there tends to be a dark line around the edges of the subject When they are farther away the image of the subject is light *toned right up to the edges* Compare body outlines in Figures 5 and 6 with Figures 7b and 7c

When experimenting with lighting, the photographer should train himself to study the visual appearance of the subject In this way he can soon learn to apply the correct amount of fill in illumination and other aspects of individual lighting He should also be careful to correlate his negative and print making techniques (see Chapters VII and IX) with his lighting As Figure 6 B C and D demonstrate merely changing the contrast grade of the paper makes a great difference in the effect of modeling and that spurious effects can be introduced with faulty printing

While the photographer cannot make lighting experiments with photoflash lamps, he can establish his lighting with photoflood lamps and then replace these with the flash bulbs for the exposure The use of more than one flash bulb is known as the "multiflash" technique It is a valuable one when the optimum lighting is required for subjects presenting depth-of field problems (and hence small apertures) or when short exposure times are needed (with unsteady patients for example)

A dimmer is valuable in experimenting with lighting, since the patient is not subjected to a prolonged period of bright light *Optimum lighting* can be quickly attained with practice At the start, however it may take time to arrive at accordingly simple standard lightings should then *be adopted for critically ill patients.* In many standard setups the lighting can be set before the patient is placed in front of the camera and this is extremely valuable when the patient cannot tolerate posing

Background Lighting

In simple and standardized setups shadows on the background usually have to be tolerated With experience however these can be eliminated by optimum lighting. The shadow from the main light quite often falls out of the camera field That from the fill in light is weak and near the subject area. A supplementary light like a keg light with a Fresnel lens can be utilized *to wash out the shadow At other* times two broad floods can be located one on each side of the background to bathe the entire area with light The farther the subject is away from the background the easier it is to control the final background tone with extra lights About 5 feet is a good minimum distance

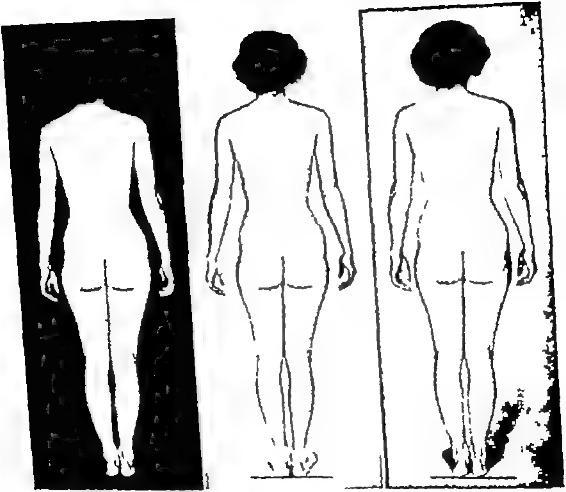


Figure VI-7: *A* A black background tends to lighten skin tones but presents no shadow problem. *B* By throwing supplementary light on a light toned background shadows can be eliminated. The background meter reading was twice that from the patient. C Here the background was half as bright as the skin. For black-and white photography the subject should be slightly lighter or darker than the background. This provides good tonal separation of the two.

of the cup are brightly lit. A dome-shaped lesion on the other hand, usually has a highlight near its apex and thus needs no supplementary lighting

Another good point to remember is one that helps to tonally separate the patient from the background When lights are closer to the patient than the camera, or are at the camera, there tends to be a dark line around the edges of the subject When they are farther away the image of the subject is light toned right up to the edges Compare body outlines in Figures 5 and 6 with Figures 7b and 7c

When experimenting with lighting the photographer should train himself to study *the visual appearance of the subject.* In this way he can soon learn to apply the correct amount of fill in illumination and other aspects of individual lighting He should also be careful to correlate his negative and print making techniques (see Chapters VII and IX) with his lighting As Figure 6 B C and D demonstrate merely changing the contrast grade of the paper makes a great difference in the effect of modeling and that spurious effects can be introduced with faulty printing

While the photographer cannot make lighting experiments with photoflash lamps, he can establish his lighting with photoflood lamps and then replace these with the flash bulbs for the exposure. The use of *more than one* flash bulb is known as the "multiflash" technique It is a valuable one when the optimum lighting is required for subjects presenting depth-of field problems (and hence small apertures) or when short exposure times are needed (with unsteady patients, for example)

A dimmer is valuable in experimenting with lighting since the patient is not subjected to a prolonged period of bright light Optimum lighting can be quickly attained with practice At the start however it may take time to arrive at accordingly simple standard lightings should then be adopted for critically ill patients. In many standard setups the lighting can be set before the patient is placed in front of the camera and this is extremely valuable when the patient cannot tolerate posing

Background Lighting

In simple and standardized setups, shadows on the background usually have to be tolerated With experience, however these can be eliminated by optimum lighting The shadow from the main light quite often falls out of the camera field That from the fill in light is weak and near the subject area A supplementary light like a keg light with a Fresnel lens can be utilized to wash out the shadow At other times two broad floods can be located one on each side of the background to bathe the entire area with light The farther the subject is away from the background the easier it is to control the final background tone with extra lights. About 5 feet is a good minimum distance

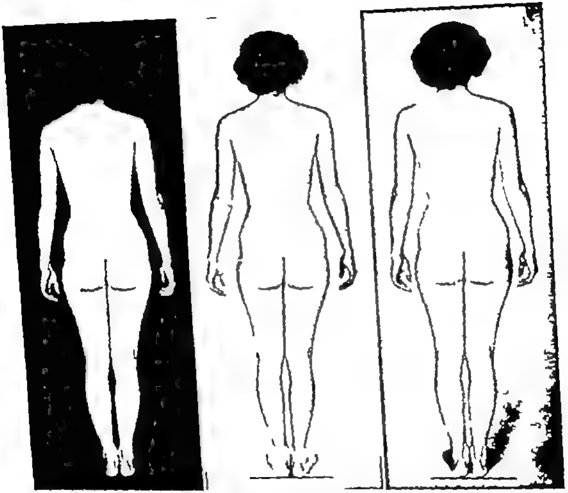


Figure VI-7: *A*, A black background tends to lighten skin tones but presents no shadow problem. *B* By throwing supplementary light on a light toned background shadows can be eliminated. The background meter reading was twice that from the patient. C Here the background was half as bright as the skin. For black-and white photography the subject should be slightly lighter or darker than the background. This provides good tonal separation of the two

of the cup are brightly lit A dome-shaped lesion on the other hand, usually has a highlight near its apex and thus needs no supplementary lighting

Another good point to remember is one that helps to tonally separate the patient from the background. When lights are closer to the patient than the camera, or are at the camera, there tends to be a dark line around the edges of the subject. When they are farther away the image of the subject is light toned right up to the edges. Compare body outlines in Figures 5 and 8 with Figures 7b and 7c

When experimenting with lighting the photographer should train himself to study the visual appearance of the subject In this way he can soon learn to apply the correct amount of fill in illumination and other aspects of individual lighting He should also be careful to correlate his negative and print making techniques (see Chapters VII and IX) with his lighting As Figure 8 B C, and D demonstrate merely changing the contrast grade of the paper makes a great difference in the effect of modeling and that spurious effects can be introduced with faulty printing

While the photographer cannot make lighting experiments with photoflash lamps, he can establish his lighting with photoflood lamps and then replace these with the flash bulbs for the exposure The use of more than one flash bulb is known as the "multiflash" technique It is a valuable one when the optimum lighting is required for subjects presenting depth-of field problems (and hence small apertures) or when short exposure times are needed (with unsteady patients for example)

A dimmer is valuable in experimenting with lighting since the patient is not subjected to a prolonged period of bright light Optimum lighting can be quickly attained with practice At the start, however it may take time to arrive at accordingly simple standard lightings should then be adopted for critically ill patients. In many standard setups the lighting can be set before the patient is placed in front of the camera and this is extremely valuable when the patient cannot tolerate posing

Background Lighting

In simple and standardized setups shadows on the background usually have to be tolerated With experience however these can be eliminated by optimum lighting The shadow from the main light quite often falls out of the camera field That from the fill in light is weak and near the subject area. A supplementary light like a keg light with a Fresnel lens can be utilized to wash out the shadow At other times two broad floods can be located one on each side of the background to bathe the entire area with light The farther the subject is away from the background the easier it is to control the final background tone with extra lights About 5 feet is a good minimum distance

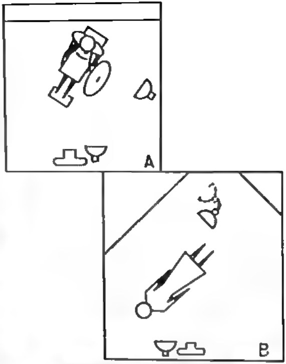


Figure VI-8 The special requirements of location lighting are discussed in the text

Care should be taken to have the back ground brightest directly behind the subject, otherwise "washed out" edges appear in the photograph and this presents an un even and amateurish appearance Lights always have "hot spots" in their beams and these should be directed to the area behind the patient

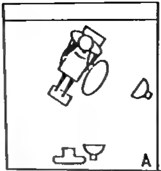
For a given lighting on subject and background the farther the patient (and hence the lights on the patient) is from the background the darker it will be The reason for this is that the subject lights throw less spill-over illumination on the background as they are moved away from it whereas the subject brightness remains unchanged if the lighting stays the same The subject shadow also becomes less in tense and thereby easier to subdue with background lights Subject and back ground brightnesses can be measured with an exposure meter to obtain the balance desired

The relative tone between background and subject affects the appearance of the patient For example, Figure 7A shows a black background While this is the easiest to use because shadows present no problems it does make the subject appear quite light in tone This is often desirable since outlines or paleness can be empha sized in this way (Dark hair can be separated with an auxiliary light as shown in Figure 3 page 107)

On the other hand, a light toned back ground Figure 7B in effect adds swarthi ness to white skins This may be all right in many instances and is useful when dark ened skin is part of the condition represented Also the results are less "oppres sive" than those with black backgrounds The effect is obtained by throwing extra light on the background (see Plan II page 104) to eliminate shadows For Figure 7B the background meter reading was twice that of the subject and there is little point in trying to increase this ratio In figure 7C the background is half as bright as the subject and the skin tones appear normal. Generally the background should be either slightly lighter or darker than the patient for black-and white prints. For color photography especially with a tinted back ground, the meter readings can be equal, see Figure II-5 Plate II page 29 for the effect obtained in color photography

Location Lighting

While such records as those in Figure 8, Plate VI opposite, can be made with flood lights, it is often more convenient on location to utilize a multiple photoflash system. Generally one slave unit and the lamp on the camera are sufficient, but for large areas two slaves may be needed for even lighting The first slave unit provides the main light This simulates il lumination from a window or dominant artificial source It casts a natural shadow like the one that is usually present on location This light should either be the closest to the main subject or have the



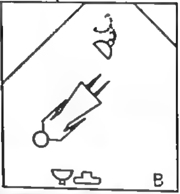


Figure VI-8 The special requirements of location lighting are discussed in the text

Figure VI-9: Sharp definition and depth of field can be obtained with a photoflash technique A small tungsten lamp was employed prior to the exposure to determine the lighting angle needed for delineating the cyst and relegating the unavoidable corneal reflex to the pupil where it least covers detail

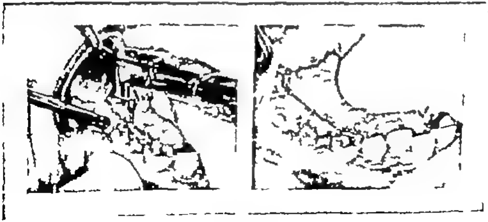


Figure VI 13: Records of oral operation Such cavity subjects are particularly well illuminated by means of an electronic flash ring light

Plate VII

stronger bulb, so that its lighting effect can predominate. It is positioned from experience with a view to providing a natural angle. It could well be placed between a window or strong room light, and the subject to yield about the same lighting as exists—provided, the subject in front of the desired background is pleasing under the existing light. The Diagram A shows a good basic arrangement. The main light should be about one to three feet above the subject, because overhead lighting is the most common.

Any other illumination should be subordinate. In particular another noticeable shadow should never be cast. This can be avoided by having the lamp at the camera as close as possible to the subject lens axis and on the same side as the main light. The subject should also be placed close to the background.

A second slave light is not needed for the subject but is used to brighten up surroundings or background areas. For example, Diagram B shows a dramatic lighting obtained with a strong bulb placed on the far side of the subject, had an auxiliary slave unit been available, it would have been located in the dotted position to lighten up the distant wall somewhat.

For illuminating complex surroundings near the subject, in order to tone down a pattern of distracting shadows and still not materially affect the main lighting, the auxiliary light can often be "bounced" off a light-toned ceiling or wall. (Avoid doing this in color photography when the wall is colored.) Allow for a loss of about ¾ of the illumination from this bulb. As a guide to the distribution of the bounce light, remember that the angle between the lamp and the spot on the ceiling and the ceiling plane will be recreated from the spot toward the area of greatest brightness from the bounced beam. Such bounced illumination, and the auxiliary flash in Diagram B (dotted) need not be counted in setting the exposure. See "Guide Numbers," page 125.

In situations like the one in Diagram A, where the background wall is close to the subject, the camera light will bounce back toward the lens. This is indicated by the light spot just off the patient's right shoulder. When the wall is dull-finished, this halo usually produces a pleasing effect of brightness in the location. On the other hand, shiny finishes like tiles cause a brilliant spot. In order to avoid such glares, the camera should be directed at about 60 degrees from the wall instead of perpendicularly—the subject, of course, should be arranged squarely in front of the camera.

When sunlight provides a bright location, photoflash lamps are merely needed for filling the shadows. The blue coated bulbs should be used for color photography.

Lighting the Eyes

With most patients the maximum exposure time possible is $^1/_{10}$ second. At such a speed, flood lighting can be employed.

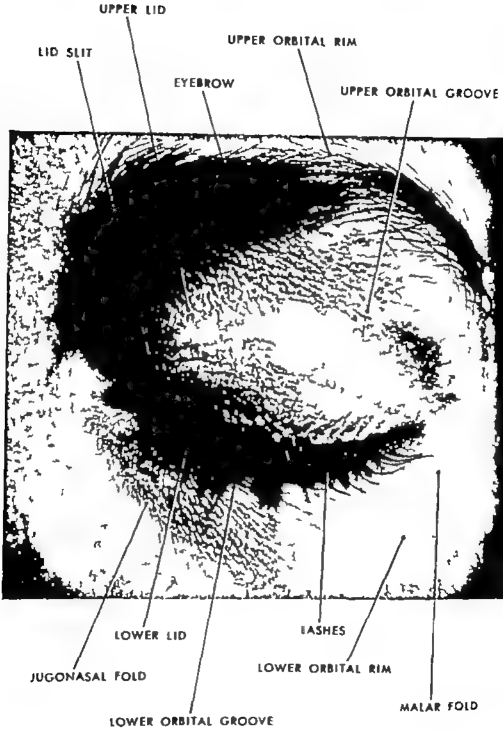


Figure VI-10 Left eye closed showing anatomy of lid

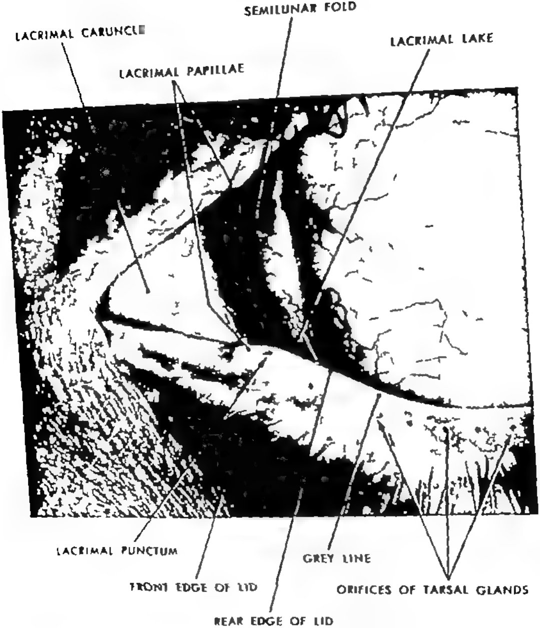


Figure VI-11: Medial region of left eye (X4) with lower lid partly everted to show secretory drainage and other details.

Figure VI-12: These illustrations while they do indicate the appearance of the palpebral conjunctiva quite well would not be suitable for showing the entities in Figure 12 even though the camera viewpoint was the same in all three instances *A* The lighting was from the left of the camera and because of the nose could not be angled sufficiently for a cross lighting Also the eye was in the primary position and this compressed the semilunar fold *B* The light (a bare midget photoflash bulb) was placed on the right side of the camera far enough toward the eye to produce crosslighting This permitted clear delineation of the lacrimal punctum Also the eye was turned laterally to extend the semilunar fold for a better presentation of its structure However the lid has been pulled down too far to show the lacrimal papilla and the orifices of the tarsal glands In addition the light was a little too high and thus shaded the upper papilla unduly

→

Fig. VI-12B

For miniature indoor color films, photoflood lamps are suitable. For professional indoor color films, 500-watt, T 10 3200 K projection lamps are desirable. Since the size of the corneal reflection depends on the size of the light source, all these lamps should be used without reflectors. Otherwise the reflector will contribute to the size of the light source. A blackened shield of some sort—say a can or a reflector painted black—may be attached to the lamp socket to protect the photographer's eye from the strong light. Before the patient is positioned, exposures are determined by taking a reading off the palm of

Better, John J. Blackened Shields for Clear Lamps in Medical Photographs. *J. Biol. Photo. A.*, 15:40-45, 1946.

Figure VI-12: These illustrations while they do indicate the appearance of the palpebral conjunctiva quite well would not be suitable for showing the entities in Figure 12 even though the camera viewpoint was the same in all three instances *A* The lighting was from the left of the camera and because of the nose could not be angled sufficiently for a cross lighting Also the eye was in the primary position and this compressed the semilunar fold *B* The light (a bare midget photoflash bulb) was placed on the right side of the camera far enough toward the eye to produce crosslighting This permitted clear delineation of the lacrimal punctum Also the eye was turned laterally to extend the semilunar fold for a better presentation of its structure However the lid has been pulled down too far to show the lacrimal papilla and the orifices of the tarsal glands In addition the light was a little too high and thus shaded the upper papilla unduly

Ring lighting is simple to use and it can only be bettered by elaborate spotlight and mirror systems that are beyond the scope of this book. Such systems provide slightly more modeling that only in specialized fields will be worth the extra outlay.

The ring light can be utilized for many close-ups and provide optimum lighting. When texture is significant, however, a cross lighting is more suitable. And the side light that is present in the power packs of many ring lights can provide this. Another point to remember is that any flat surface perpendicular to the camera axis will reflect a glare from the ring light back into the lens. The temple, the palm of the hand and parts of the back are typical examples. When a rounded surface is photographed with the ring light the highlight from it will be in the center of the field. Therefore, the most important features of the subject should be framed somewhat off center. These are factors in the optimum use of the ring light and need not concern those interested in the simplest methods—although they are easy to understand and should eventually be adopted by anyone using this form of lighting.

Summary of Lighting Steps

Once the principles of optimum lighting are understood, they are easy to apply. The reason is that the effect appearing in the photograph can be observed visually before the exposure is made. It is true that discrimination in judging the lighting balance comes with experience. This can be hastened by recalling the visual appearance when the photograph is studied. The lighting ratio between main and fill-in illumination can be measured with the exposure meter. This should be done for each light separately and care not to cast shadows into the area must be taken. Exposure readings are taken with both on. Supplementary lighting seldom affects the result and usually should not fall on the main subject.

The ratio varies from 4/1 to 2/1 for black-and-white prints, and from 3/1 to 1/1 for color photography. Background ratios have been discussed previously.

The lighting steps are shown (left to right) in Figure 14. Preliminary positioning is assumed to have been done. First, turn on two lights near the camera to find the final pose for revealing the most significant aspect of the subject. This can be found by having the patient change position slightly (second photograph) and by observing the effect from the proposed camera location. Third, turn on the lights separately, first on one side of the camera and then the other. This will determine the side for the main light. Move this to the most suitable angle and height, noting when the significant feature is well delineated. (It is assumed that for Figure 14 the area just below the "x" is to be most promi-

the hand held at the distance from the lamps that the subject will be The use of standard lighting distances simplifies making the exposure

Flood lighting is usually done with a lamp at each side of and slightly higher than the camera unless the condition demands directional lighting The large PS-25 lamps are generally used with a view camera and the T 10 bulbs in a setup for a miniature camera A dimmer must be employed with flood lighting because the eye can tolerate lamps at full brilliance for only a short time Blue eyes can bear the light less than brown eyes diseased eyes or those with pupils dilated with drugs cannot withstand even ordinary photographic intensities In the latter instance it is often necessary to forego flood lighting and use photoflash lamps

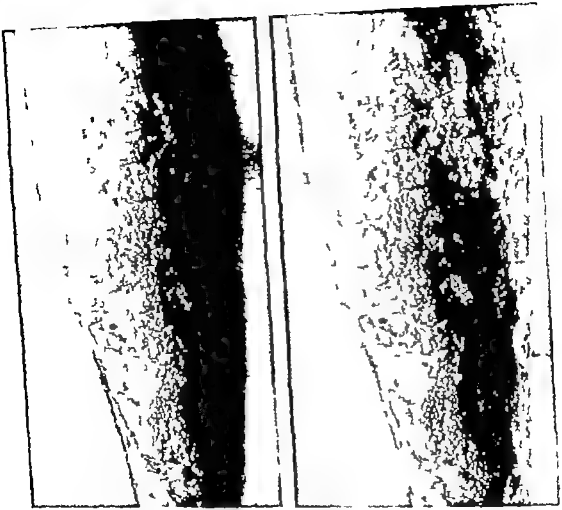
To employ a small aperture for good depth of field and fast exposures in making closeups of a single eye photoflash lamps are needed † They can be synchronized with the shutter or used in the open-flash technique To provide small light sources they should also be utilized with blackened reflectors or without reflectors The photoflash technique also allows the use of one small light source which results in a single tiny corneal reflection With a single lamp too it is possible to obtain maximum emphasis of any texture that may be significant on the eyeball In plastic-surgery cases in which the face must appear in repose and in other cases in which slight or moderate squinting militates against a normal appearance flash bulbs are always indicated The best lighting angle and the position of the corneal reflection can be determined by first lighting the eye with a small tungsten lamp such as an automobile bulb The result of this technique is shown in Figure 9 Plate VII page 116 Exposure data are on page 143

Figure 10 shows the sculptural quality obtainable with small sources in making extreme close-ups of the eye or any other subject This same optimum technique permits the maximum delineation of fine or faint details as demonstrated in Figure 11 The need for particularly careful positioning and lighting of such subjects is discussed in Figure 12 A fine and complete monograph on eye photography is Dr Peter Hansell s *A System of Ophthalmic Illustration* also in the American Lecture Series

Ring Lighting

In Figure III-3 page 38, is shown an electronic flash ring light often employed in the simplified technique This light also provides optimum lighting for cavities such as the mouth—especially when a manual operation is being recorded (See Figure VI 13 Plate VII page 116)

† When photoflash lamps are used close to the patient it is extremely important that adequate protection be provided against accidental explosion of the bulb as a result of the flash.



←

cused and the effect restudied. Minor changes in position and main lighting may be indicated, but these should be slight. A systematic approach like this will soon take the mystery out of good lighting.

Guide Numbers

These figures are invaluable in calculating photoflash and electronic flash exposures, see Tables VI and VII next chapter

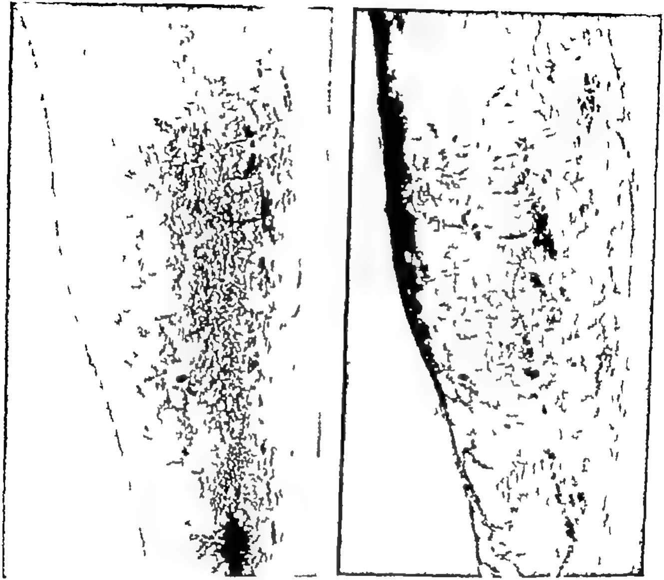
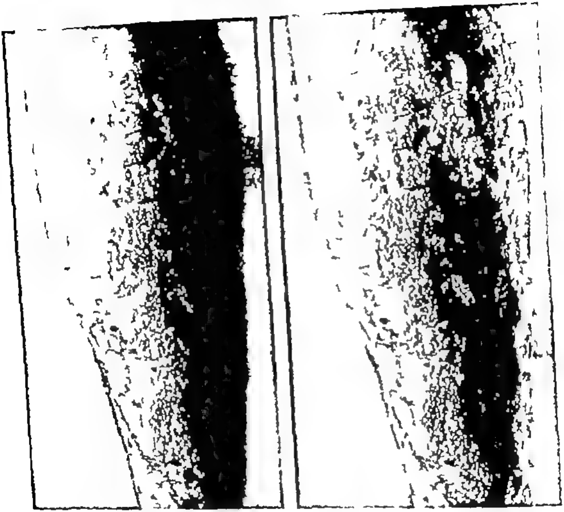


Figure VI 14: Steps in the establishment of good lighting (see text)

nent) Fourth place the fill in light close to the camera axis and study the effect of moving it to and fro to vary the intensity When a suitable distance has been established swing the fill in light away from the main light and the camera maintaining the same distance to find out whether the fill in light could better be placed off the camera axis—usually this will not be so

At this juncture the camera can be fo-



←

cused and the effect restudied. Minor changes in position and main lighting may be indicated, but these should be slight. A systematic approach like this will soon take the mystery out of good lighting.

Guide Numbers

These figures are invaluable in calculating photoflash and electronic flash exposures, see Tables VI and VII, next chapter

The distance (in feet or inches depending on the basis for the numbers) between the lamp and the subject is divided into the number This yields the aperture at which to set the diaphragm Sometimes a certain f/ number is desired, then this aperture setting is divided into the guide number to find the distance at which to place the lamp Guide numbers differ with synchronized shutter speeds, since the utilized proportion of the lamp s total light output also varies with the exposure time

For multiflash exposures, the guide number should not *be multiplied by the number of lamps* Rather, the average distance of the lamps should first be found Then the f/ number should be calculated on the basis of *one* lamp at the average distance Finally the exposure is adjusted in accordance with the number of lamps in the usual way For example if two lamps are utilized, the diaphragm is closed down one stop more than that calculated for a single lamp at the average distance

To determine a guide number for an electronic flash lamp for which no data is available, test exposures can be made on the film to be used. This should be done at a given distance—say 5 feet Were the best exposure that one made at f/8 in this instance the guide number would be 40 It could then be used at other distances with the same film for example, 4 feet at about f/11 The number varies with film speed, so that other tests might be needed

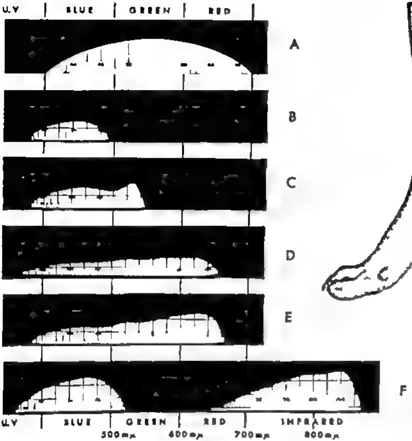
CHAPTER VII FILMS AND FILTERS, COLOR PROCESSES

There are numerous black-and-white films that are available for the medical photographer. This chapter discusses the characteristics and processing of suitable ones. It also deals with color films here the variety is not so great. Filters for use with both are described. Exposure Tables for some of the standard setups are also given.

Black-and White Films

The many and diversified fields in which photography plays an important role have necessitated the manufacture of numerous types of films. These films differ from one another in their characteristics—their response to light, and the processing that they require. An understanding of the properties of the materials available will not only aid in the proper selection of a film, but will also be reflected in the improved quality of the photographs produced.

Specification sheets for films (published by manufacturers) describe the general properties of a film, indicate its speed, color sensitivity filter factors give data on exposure contrast, development, sensitometric curves, time-temperature development curves, graininess, resolving power (for miniature films only) fixing, recommended safelight, notching code (sheet films only) and sizes available While some of the data they contain are readily understood, an explanation of the more technical



Cod : A, Sensitivity of human eye B Non-color-sensitized film violet blue C Orthochromatic film green added D Panchromatic film Type B red added (approximates eye sensitivity) E Panchromatic film Type C high red sensitivity F Infrared film: violet blue and infrared (first two controlled by red or infrared filter)

Figure VII 1 Typical spectrograms showing the color sensitivity of certain film sensitizing types to tungsten light Inset Orthochromatic darkening of reds with pan film and blue green filter

points will help the medical photographer to appreciate their significance and proper use In this chapter therefore film characteristics are discussed and illustrated

Color Sensitivity

The color sensitivity of a black and white emulsion defines the degree of its photographic response to light of various wave lengths or colors While the average normal eye is sensitive to blue green and red, as well as mixtures of them, this is not necessarily true of photographic film In fact plain silver halide, the fundamental sensitive element in all emulsions is sensitive only to blue and ultraviolet Incorporated in modern orthochromatic, panchromatic and infrared emulsions, however are sensitizing dyes that render the film sensitive to other colors of light The type of sensitizing is one of the most important photographic characteristics of a

film because it profoundly affects both the handling of the material and the results obtained. Color sensitivity is indicated by wedge spectrograms similar to those shown in Figure 1.

The bearing this property has upon the tone values reproduced in a medical record is shown in Figure 2. A color to which a film is not sensitive is recorded dark in the photograph. It should be remembered, however the few colors in Nature (or in medicine) are pure primaries. For example a red rash reflects some green and blue light and this causes it to appear as a gray in the orthochromatic photograph—if the rash were *pure* red it would record as black. The photographer should guard against making lesions too dark in some of his records, otherwise a false visual impression will be created.

It is true that in order to "map" the distribution of pale areas clearly overemphasis may be necessary. Yet these records should be accompanied by a photograph showing the visual appearance as nearly as it is possible to do so with black-and-white materials. Sometimes a strong orthochromatic rendition will be needed even for the

Figure VII-2: The results of film sensitivity are demonstrated with this mild case of pityriasis rosea. *A*, Even though the rash was faintly pi k and scarcely visible, the lack of red sensitivity of the orthochromatic film has caused the papules to record dark. *B* Panchromatic film was utilized for this photograph and its red sensitivity produced densities on the negative that caused the pink areas to record almost as light as the surroundi g skin.

visual reference more often a "mild ortho" or a "corrected" rendering, made with a panchromatic film and a pale blue-green or a correction filter will be better. An orthochromatic film is usually needed for "mapping" dermatological lesions.

Color sensivity has a direct bearing on the filters that can be used and their filter factors, the monochromatic rendering of colored subjects, the effect of the color quality of illumination on the speed of the film, and the proper safelight color to be employed.

Filters and Filter Factors

Photographically speaking, a filter is a means of altering the character of the light entering a lens in order to produce a specific result in the negative image. What a filter actually does to achieve its effect is to absorb certain colors or wave lengths of light that would otherwise result in exposure of the film. The filters that can be used depend on the color sensitivity of the film. *For example, a red filter can be used only with a material sensitive to red light.*

In some instances it is desirable to lighten a color rendered in tones of gray, and in others to darken it. In general, a colored object appears dark in the print if the negative is exposed through a filter whose color is complementary to the color of the object. Conversely, a colored object appears light in the print if the *negative is exposed* through a filter of the same color as the object. For example, a red object photo*graphed through a blue-green filter will be* recorded dark, and when photographed through a red filter will be recorded light. While the desired result can often be obtained without a filter by selecting a film of the proper color sensitivity, as discussed in the section, *Monochromatic Rendering of Color Subjects*, the use of filters is particularly important to those utilizing miniature cameras, for which orthochromatic films are not readily available.

The filter factor—the increase in exposure required when a filter is used—depends *primarily on the color sensitivity of* the material, although some exposure increase is required because of the density of the filter without regard to its color. A negative material with a large portion of its sensitivity in the blue violet requires a much greater exposure through a yellow filter, which absorbs most of the light, than does a panchromatic material which, being sensitive to all colors, is able to utilize the *red and green light transmitted by the* filter. Filter factors of the most commonly used filters are indicated by a table in the instructions for the film employed.

Monochromatic Rendering of Colored Subjects

Panchromatic film and the proper correction filter provide the only means by which the brightness of the colors seen by the eye in the original subject are closely approximated by the brightness values of

the photographic tones. Films that are not sensitive to a certain color will render that color considerably darker than the color appears in the original. This fact is widely utilized in medical photography. For example, it is often desirable when photographing lesions, to enhance the contrast between normal skin and slightly reddish areas. In such instances, an orthochromatic film will prove helpful, since it will render the reddish areas darker than they appear to the eye. It is also valuable to use a light blue-green filter with panchromatic films to obtain essentially an "orthochromatic" rendition. On the other hand, when making photographs in surgery—where the area of interest is predominantly reddish—a panchromatic film, without a filter will provide the most satisfactory detail in the red areas themselves.

Effect of Color Quality of Light

The color sensitivity of a film has a direct bearing on its speed because of the differences in the color quality of the various light sources employed. For example the proportion of bluish light to which all films are most sensitive is much higher in daylight than in tungsten light, which contains a high percentage of yellow orange and red. Therefore two films—one non-color sensitive and the other panchromatic—may have approximately the same speed in daylight, but because the panchromatic film is able to utilize the red, orange, and yellow it is much the faster when exposed to tungsten light.

Safelight Color or Transmission

A fourth aspect of color sensitivity is that of the influence of processing room illumination on the different types of film. It is the function of a safelight to transmit a maximum of visible light to which the film is least sensitive. Orthochromatic materials, that are sensitive only to blue-violet, blue and green, can be handled without danger of light-fog if a safelight transmitting only deep red is properly employed. However panchromatic films, which are sensitive to all colors, are preferably handled only in total darkness. If a safelight is used at all with such materials, it must transmit light of very low intensity to which the eye is most sensitive and be employed for only brief periods after development has started. Referring to the top spectrogram in Figure 1, it can be seen that the eye is most sensitive to green light. Therefore the proper safelight for panchromatic films is a green one used at a low enough level to minimize its effect on the film.

Speed

With respect to the speed of a film to be exposed in light of known quality and intensity the factors of paramount importance to the medical photographer are the fastest shutter speed that can be used at a chosen aperture to stop movement, the

---

For example the Kodak Wratten No. 60 Filter—filter factor, 2.

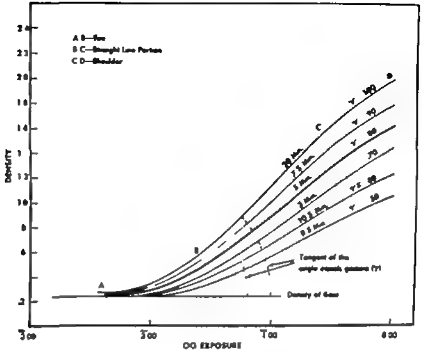


Figure VII 3: Typical family of characteristic curves

smallest aperture that can be used at a chosen shutter speed to obtain adequate depth of field, and, with recommended de velopment, to secure a negative capable of giving an excellent print For negatives of satisfactory quality some films require more exposure than others under similar light conditions This is due partly to the difference in their color sensitivity but chiefly to differences in the inherent gen eral sensitivity of the film For example, two films having similar relative color sensitivities may have different relative speeds, one requiring two times or more the exposure of the other to yield the same printing quality in the negative

Exposure meters are set on the basis of film ratings These incorporate the films into exposure groups that are tabulated in the instructions for the meters Film manu facturers also provide exposure ratings for their products These ratings are now called Exposure Indexes

Latitude

The range of tones that can be repro duced by a film is known as its exposure scale or exposure latitude Information re garding the exposure latitude of a film is obtained from its characteristic curves a typical family of which is shown as Figure 3 The characteristic curves are obtained

by making a series of step exposures, on a strip of the film to be tested, in an instrument called a sensitometer. Each exposure is greater than the preceding by a constant factor. After development under carefully controlled conditions, the densities of the steps are measured on a densitometer. To obtain the curve, the densities are plotted against the logarithms of the exposures that produced them. It will be seen in Figure 3 that each curve has three parts: a "toe," a straight line portion, and a "shoulder." The latitude is indicated as the exposure interval between a point fairly low on the toe of the curve, and another point located on the shoulder. Since the brightness range of most subjects is considerably less than the exposure latitude of the films recommended for medical photographic procedures, there is a reasonable safety margin in the exposure that can be given such subjects.

Contrast

Objects and details in the field of vision can be seen only when they contrast with their surroundings. This visibility may be due to a difference in color or brightness, or to a combination of the two. Just how plainly any detail will stand out depends primarily upon how much the contrast between it and the background or surrounding areas exceeds the minimum difference which the eye can perceive.

Since contrast is basic to the visibility of details, a clear understanding of the factors affecting it is important in order to achieve optimum tone reproduction. These factors may be grouped in three categories: those associated with the subject, with the film, and with the print. (The last mentioned factors will be discussed in the chapters on making prints.)

Subject Contrast

While color differences are readily apparent, differences in the brightness of various parts of the subject are often not fully appreciated. Subject variations are dependent upon the reflecting power of the area of interest and the variation in incident illumination. The latter is the more important to the medical photographer. For example, with balanced lighting, small blisters on white skin exhibit high brightness, but the area of interest as a whole has a short brightness range. In fact, the blisters may even resemble normal skin in a photograph made under these conditions. If, however, modeling is achieved by the unbalanced cross lighting produced by a spotlight, the blisters will cast shadows on the light skin, resulting in a greater contrast of subject brightnesses.

Negative Contrast (Gradient)

Contrast or gradient is the extent to which subject brightness differences are re-

Density = Log $\frac{1}{\text{Transmission}}$ where Transmission = $\frac{\text{Transmitted Illumination}}{\text{Incident Illumination}}$

produced as density differences in the negative. It depends on inherent properties of the film and factors associated with exposure and development

Emulsion Contrast: Inherent contrast of the emulsion is an important factor in governing the contrast of the negative, since it determines the useful range of negative contrasts that can be produced through control of development While a film can be developed to a contrast higher or lower than that within the contrast range for which it was designed such over or underdevelopment tends to result in a negative of inferior printing quality

Negative materials range from low-contrast portrait films through medium-contrast films for commercial and general medical photography to extremely contrasty line-copying films intended to yield black-and white negatives completely lacking in intermediate tones

Effect of Exposure on Contrast An underexposed negative is lower in contrast as well as lower in density than one fully exposed A negative that is greatly overexposed is also lower than normal in contrast but exhibits high density Such negatives have the main tones of the subject recorded in the toe or shoulder regions see Figure 3

Development Contrast: The portions of a film that have received the greatest exposure gain density more rapidly during development than do the areas that have received less exposure As development proceeds, therefore the contrast between the highlights and shadows increases. In the sensitometric determination of the properties of films the contrast obtained by development is designated by the term gamma (,) Gamma is defined as the tangent of the angle formed by the straight line portion of the characteristic curve and the horizontal axis Over each curve are printed the development time in minutes given the film (in a recommended developer) to produce the curve and the gamma of the film for that development time as indicated by the curve

It might be well to mention here that for most medical subjects development should be regulated to produce a gamma of approximately 0 8 If however the brightness range of the subject is low improvement in the rendition of detail can often be obtained by prolonging development until a higher contrast is reached in the negative If as in the problem of photographing blisters against white skin a small brightness difference exists increased development time will help to show the blisters more clearly Development should not be carried too far however otherwise it will produce fog in the negative leading to pictures that lack brilliance

The important factors that influence development contrast are the composition of the developer the temperature of the developer the time of development the agitation given the film the degree of exhaustion of the developer the effect of

fog; the effect of the color (brownishness) of the negative image.

Developer Composition. High-energy fast working developers are capable of producing negatives of much higher contrast than slower working developers. The developers recommended for each film are given in its instructions.

The question is often asked, "Can I develop my photographic film in x-ray developer?" X-ray developer is also a high-energy developer, being designed to produce the high contrast desirable in radiographs. Since moderate contrast is usually desired in photographic negatives of medical subjects, development with x-ray developer is more difficult to control than with the recommended slower working developers, and is therefore apt to produce negatives of inferior printing quality.

Temperature of Developer: Negative contrast for a given development time varies as the temperature of the developer is varied—it increases as the temperature is raised (up to a point where fogging begins to reduce contrast). It decreases as the temperature is lowered. In any event, the temperature should deviate from 68°F as little as possible. In situations where it is not practicable to maintain the developer temperature at 68°F., time-temperature development curves indicate the correct development time for the requisite temperature. A typical group of curves is reproduced as Figure 4. When it is necessary to develop at temperatures above 75°F., special tropical developers and hardeners should be employed.

Time of Development: Since negative contrast increases over a wide range with increase in development time, variation of this factor is the most satisfactory method of controlling negative contrast for a given subject, film, and developer. The development time required to produce any gamma desired for special situations at a temperature of 68°F. is easily determined from a time-gamma curve for the recommended developer. A typical example is reproduced as Figure 5.

Agitation: The rate of development is also influenced by the agitation given the film during the development interval, contrast increasing with increased agitation. If the film is developed in a tray, continuous agitation should be employed, whereas with tank development, agitation should be intermittent. Recommended development times for continuous and intermittent agitation are therefore given in instructions. If the development time with in-

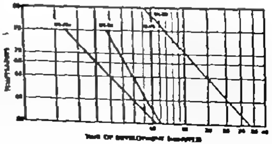


Figure VII-4 Time-temperature development curves.

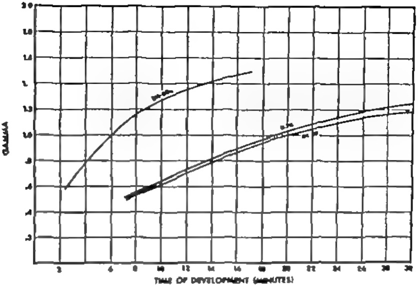


Figure VII 5: Typical time gamma curves

termittent agitation is known and it is desired to use tray technique the interval should be decreased 20 per cent If the development time with continuous agitation is known and a tank is to be used, the development interval should be increased 25 per cent.

Exhaustion of Developer: During development, several reactions take place that exhaust the developer and produce by products that restrain development. This restraining action is analogous to a reduction in the speed of the film so that even with prolonged development in a nearly exhausted solution, correctly exposed negatives will have less contrast than negatives developed in a relatively fresh developer and may appear to have been given insufficient exposure An increasingly longer development time is required to produce a definite degree of contrast as the developer is used. It is difficult to determine accurately the point at which the developer should be discarded, but it is inadvisable to use a fresh solution when the time required to obtain good contrast is approximately 50 per cent longer than that for fresh developer Inasmuch as developers are relatively inexpensive, it is poor economy to try to use nearly exhausted solutions by prolonging the interval the films are left in them

Fog Whether caused by extraneous light or faulty processing, fog seen as distinctly grayish deposit of silver—best observed in the otherwise clear unexposed margins of the film—tends to reduce contrast, particularly shadow detail, by veiling the entire negative image.

Color of Negative Image: Pyro develop-

ers and many fine-grain developers, produce a brownish image in the negative that has an effect similar to that of a filter absorbing a portion of the blue-violet light to which printing papers are most sensitive. The brownishness is in proportion to the density of the silver deposit in the negative. As a result, the printing contrast is slightly higher than that of an image that transmits more of the blue-violet light.

Processing

The factors of development as they affect contrast have just been dealt with. The developers recommended for medical photography with specific films are given in Table IV.

It should not be overlooked that care and cleanliness are important in the dark room. The procedures should be systematically carried out—haphazard methods do not lead to consistently good results.

Whenever possible the developer and all succeeding baths should be held to a temperature of 68 F or 20°C. This includes the wash water. Processing at elevated temperatures or changing from baths of one temperature to others of markedly different temperatures are likely to cause troubles such as reticulation and excessive softening of the emulsion. Information on processing at "tropical" temperatures can be obtained from film manufacturers.

For even, non-streaky and constant results tank agitation should be consistent during development. It is best accomplished by withdrawing the hangers and draining first one lower corner then immersing and withdrawing to drain the other corner. The hangers should be rapped to dislodge air-bells upon replacement. A group of hangers should be handled together to avoid scratches. This agitation should be given only once every minute.

Rinsing

Films should be given a liberal rinsing in clean water or in an acid rinse bath before they are fixed. This minimizes the contamination of the fixer and lengthens its life and *maintains its hardening properties.*

Fixing

Films should be fixed for twice the time it takes to clear the milky undeveloped, emulsion from the film. Fixing times for reasonably fresh solutions are given in manufacturers instructions. Excessive fixing is likely to increase the graininess of the negatives, destroy shadow detail, or decrease the image contrast. Insufficient fixing may result in a soft emulsion and in stains with storage.

Washing

The absorbed fixer must be thoroughly removed from the negative or fading and stains will ensue. This can be done with a ½ to one hour washing in running water that has free access to the film.

Drying

Adhering water should be swabbed from

TABLE IV

BLACK-AND-WHITE FILMS FOR THE PHOTOGRAPHY OF PATIENTS

(ASA exposure indexes for tungsten light, graininess characteristics and developers are indicated from Manufacturers' data)

Required Applications and Filter Necessary	ANSCO		DU PONT	KODAK	
	Sheet	Roll	Sheet	Sheet	Roll
Photography of posture morphologic anomalies, dark red areas with light or normal peripheries, "portraits", surgery. (No filter needed.) on Photography in which colors are to be rendered in their correct (visual) brightness relation. (Green "correction" filter needed.)	Super Hypan (Permadol)	Super Hypan (Permadol)			
	Superpan Press (Index 80 medium graininess, Normadol)	Superpan Press (Index 80 med. graininess Normadol)	Arrow Pan (Index 125, medium grain, 16-D)	Super Panchro-Press, Type B (Index 100, moderate graininess DK-60a Microdol)	Plus-X (Index 64 moderate graininess DK-60a D-76 Microdol)
	Type 292 (Index 32 very fine graininess Normadol)	Supreme miniature (Index 32 fine graininess, Normadol)	Fine Grain Pan (Index 20, fine grain 16-D)	Panatomic X (Index 25 very low graininess Microdol)	Panatomic X (Index 20 very low graininess Microdol)
Photography of light-red areas with light or normal peripheries in which enhancement of contrast between the red areas and peripheries is desired. (No filter needed with "Ortho" films. Light blue-green filter needed with "Pan" films.)	Triple S Ortho (Index 64 medium graininess, Permadol)	Same as above but use 66 filter factor 2	High Speed Ortho (Index 64, medium grain, 16-D)	Royal Ortho (Index 125 moderate graininess DK-60a)	Same as above but use 66 filter factor 2

The graininess of this film can be made considerably lower by development in Kodak Microdol developer

the negative with cotton or a sponge. Water drops, if allowed to remain on the drying negative, are almost sure to cause spots that produce defects when the negative is printed.

A Kodak Photo-Flo bath ensures quick draining and is valuable in saving time when many negatives are to be dried.

Image Definition

Maximum detail and sharpness are required in medical photographs. While there are a number of factors that influence the definition of the photographic image, only those associated with the film—graininess and resolving power—will be discussed here.

Graininess

The negative image consists of finely divided particles or grains of metallic silver that are distributed throughout the emulsion. The size of these particles and their tendency to appear clumped together vary with the type of emulsion and the development given the negative. Any projection print of sufficient magnification will exhibit a sandy appearance that is a result of the enlarged images of the apparent grain clusters. Graininess, as this is called, is, of course objectionable in medical photographs, since it tends to destroy fine detail and to disturb the rendering of smooth surfaces. It is apt to be a serious problem however only when small negative sizes, 35-millimeter in particular are employed, since these require fairly great magnification in printing. Nevertheless, when enlarged prints are to be made from any negative, graininess should be considered and measures adopted to control it.

A certain graininess is inherent in every emulsion. In general, graininess increases with increased emulsion speed. Very fast films tend to be more grainy than slower films. Graininess also increases with development contrast, however most normal developers yield approximately equal graininess in a given film if the same degree of development contrast is achieved. Special fine-grain developers give lower graininess, although the negative usually requires more exposure than would otherwise be given. In general, the denser the negative the greater the probability of encountering objectionable grain in the photographic print.

Resolving Power

The ability of a film to record fine detail distinguishably can be measured and is known as resolving power. It is expressed by the number of lines per millimeter that can be distinguished under the microscope as separated in the photographic image on a film that has been given recommended processing. While resolving power is influenced by graininess, it is also dependent on other characteristics of the negative. Resolution falls off at high and low exposure values, reaching a maximum at some

intermediate exposure at which the resolving power figure is selected. The loss of resolution caused by under and overexposure is an important reason for exposing miniature negatives correctly

Acutance Resolving power is not always a true indication of the visual sharpness of the image—especially with many present day films Sharpness is a subjective impression received by the observer—accordingly it is difficult to assign definite values of sharpness to photographic images To overcome this problem a method has been devised for making objective measurements of a quantity called *acutance* which agree with sharpness judgments made by observers These measurements are based on the variation in density across the boundary of a knife-edge image On the basis of such measurements films for clinical photography can be placed in groups bearing sharpness ratings from low to very high As a base for comparison Kodak Panatomic-X miniature film is in the last category

Notching Code

To permit the convenient manipulation of films in total darkness, a means of identifying the type and emulsion side of the film has been incorporated in all sheet films Each film carries a series of identification notches on one short side When the notches are on the right side of the top edge the emulsion side of the film faces the operator

Tables

Table IV shows suitable films for medical photography Enough are given to cover most of the contingencies in photographing patients

Table V gives exposure data for the standard lighting plans discussed in Chapter VI Table VI indicates the guide numbers for flash lamps at average distances and Table VII those for close-up photography such as that of the eye or mouth

Color Films

The use of color materials in medical photography has become a most valuable practice So many clinical conditions depend on color for recognition and so many tissues fluids, and anatomical landmarks have distinctive colors that a color photograph provides the most concise record This is particularly necessary in preparing illustrations for teaching—the student needs to become oriented with the least amount of scrutinizing In that way the pathology can receive his major attention

One characteristic of all color films should not be overlooked No practical color process can represent colors with photometric accuracy There are spectral limitations even in the best dyes available or likely to be discovered Again all processing procedures are subject to slight variations Hence any color process can only be held to within certain tolerances with respect to absolute accuracy That

these tolerances are practical and useful ones is attested to by the widespread utilization of color films in numerous fields.

In clinical applications it is often desired to record subtle color changes in the appearance of a lesion. This is practical if the following suggestions are taken. When the first transparencies are finished they should be compared with the subject. This should be done by lighting the subject with the photographic lights and holding a white blotter under one of the lights to provide an illuminated background for the transparencies. The results can now be compared with the original. The most suitable exposure can first be chosen. Then, if there are slight color differences between the original and result, a pale color-compensating filter can be selected and bound with the transparency to bring the two closer together. This procedure can be done after each photographic session and provides as accurate a record of progress as it is possible to attain. A standard trans

TABLE V

EXPOSURE DATA FOR THE PHOTOGRAPHY OF PATIENTS

Based upon the use of 500-watt, PS-25, 3200°K Mazda Lamps for Professional Color Films, or upon No. 2 photoflood lamps for Miniature Color Films or either type of lamp for black-and-white films. The employment of matte reflectors is assumed. (Hyphen indicates that position halfway between the two aperture markings should be used.)

Film Exposure Index	Plan	Exposure Time and Relative Aperture for Various Scales				
		1/1	2/3	1/2	1/4	Less than 1/4
10	I				1/5 sec.—f/8-11	1/5 sec.—f/11
	II					1/5 sec.—f/8
	III	1 sec.—f/11	1/2 sec.—f/8-11	1/2 sec.—f/11	1/2 sec.—f/11 16	
16	I				1/10 sec.—f/8	1/10 sec.—f/8-11
	II					1/5 sec.—f/8-11
	III	1/2 sec.—f/8-11	1/2 sec.—f/11	1/2 sec.—f/11 16	1/5 sec.—f/8-11	
20	I				1/10 sec.—f/8-11	1/10 sec.—f/11
	II					1/10 sec.—f/8
	III	1/2 sec.—f/11	1/5 sec.—f/8	1/5 sec.—f/8-11	1/5 sec.—f/11	
50	I				1/25 sec.—f/8-11	1/50 sec.—f/8
	II					1/25 sec.—f/8
	III	1/5 sec.—f/11	1/5 sec.—f/11 16	1/10 sec.—f/11	1/25 sec.—f/8	
64	I				1/25 sec.—f/11	1/50 sec.—f/8-11
	II					1/25 sec.—f/8-11
	III	1/5 sec.—f/11 16	1/10 sec.—f/11	1/10 sec.—f/11 16	1/25 sec.—f/8-11	
100	I				1/25 sec.—f/11 16	1/50 sec.—f/11
	II					1/25 sec.—f/11
	III	1/5 sec.—f/16	1/10 sec.—f/11 16	1/10 sec.—f/16	1/25 sec.—f/11	

Plan not devised for this scale.

intermediate exposure at which the resolving power figure is selected The loss of resolution caused by under and overexposure is an important reason for exposing miniature negatives correctly

Acutance: Resolving power is not always a true indication of the visual sharpness of the image—especially with many present day films Sharpness is a subjective impression received by the observer—accordingly it is difficult to assign definite values of sharpness to photographic images To overcome this problem a method has been devised for making objective measurements of a quantity called *acutance* which agree with sharpness judgments made by observers These measurements are based on the variation in density across the boundary of a knife-edge image On the basis of such measurements films for clinical photography can be placed in groups bearing sharpness ratings from low to very high As a base for comparison, Kodak Panatomic-X miniature film is in the last category

Notching Code

To permit the convenient manipulation of films in total darkness a means of identifying the type and emulsion side of the film has been incorporated in all sheet films Each film carries a series of identification notches on *one short side* When the notches are on the right side of the top edge, the emulsion side of the film faces the operator

Tables

Table IV shows suitable films for medical photography Enough are given to cover most of the contingencies in photographing patients

Table V gives exposure data for the standard lighting plans discussed in Chapter VI Table VI indicates the guide numbers for flash lamps at average distances and Table VII those for close-up photography such as that of the eye or mouth

Color Films

The use of color materials in medical photography has become a most valuable practice So many clinical conditions depend on color for recognition and so many tissues fluids and anatomical landmarks have distinctive colors that a color photograph provides the most concise record This is particularly necessary in preparing illustrations for teaching—the student needs to become oriented with the least amount of scrutinizing. In that way the pathology can receive his major attention

One characteristic of all color films should not be overlooked No practical color process can represent colors with photometric accuracy There are spectral limitations even in the best dyes available or likely to be discovered Again all processing procedures are subject to slight variations Hence any color process can only be held to within certain tolerances with respect to absolute accuracy That

differentiation and thus simplifies delineation.

Of course in concerted studies of morphology or posture color films are not needed. Occasional studies of this nature however for insertion into collections of other types of color records, are best made on color films. In this way distracting transitions from color to black-and-white do not occur in a presentation of the cases.

Types of Color Films

There are two major kinds of color films that the medical photographer will be concerned with. The distinction involved lies in the processing—one type can be processed by the photographer or in photofinishing plants, the other by the manufacturer or in specialized photofinishing laboratories. Useful positive films and their day and artificial-light exposure indexes are as follows.

Films in the first category are ROLL, MINIATURE ROLL—Anscochrome, 32,—Super Anscochrome 100, 50- Ektachrome 32, 16(F) SHEET—Anscochrome 32, 25 Ektachrome 12, 10. These are for use in daylight or 3200 K (type B film) illumination. In the second category are 35-millimeter and Bantam Kodachrome Films. Daylight, index 10- and Type F index 12, for photoflash illumination.

Kodachrome Professional Film, Type A (index 16, for photoflood illumination) is only produced in 35-millimeter 36-exposure rolls. The other 35-millimeter films

"K" stands for Kelvin, and this figure indicates the color-temperature of the source. The spectral quality of the light here is that of a perfect radiator burning at a temperature of 3200 on the Kelvin scale of temperature.

TABLE VII

PHOTOFLASH LAMP GUIDE EXPOSURE NUMBERS FOR CLOSE-UP PHOTOGRAPHY

(Given for bare lamps without reflectors, or in blackened ones, and for distances in inches)

EXPOSURE SPEED	SHUTTER SPEED	GUIDE NUMBERS* FOR LAMPS SHOWN		
		No. 5 or No. 25	No. 22 or No. 2	M 5
12 16	1/25	336	490	326
	1/100	275	410	210
	1/200	240	336	155
	1/400	180	240	125
25	1/25	384	528	384
	1/100	324	444	240
	1/200	264	384	190
	1/400	192	264	145

To calculate the f/number divide the guide number by the distance in inches between lamp and subject and select the nearest aperture stop or half-way position.

Same guide number holds for open-flash technique.

TABLE VI

PHOTOFLASH LAMP GUIDE EXPOSURE NUMBERS FOR THE PHOTOGRAPHY OF PATIENTS

(Given for lamps in standard synchronizer or flasholder reflectors and for distances in feet)

FILM EXPOSURE INDEX	SHUTTER SPEED	GUIDE NUMBERS FOR LAMPS SHOWN	
		No 5 or No. 25	No 22 or No. 2
12 (Type F color)	1/25† 1/50 1/100 1/200	95 85 75 60	140 130 110 85
16	1/25† 1/50 1/100 1/200	80 70 60 45	110 100 90 70
20	1/25† 1/50 1/100 1/200	110 100 85 65	160 140 120 95
32	1/25† 1/50 1/100 1/200	120 110 95 70	180 160 140 100
64	1/25† 1/50 1/100 1/200	200 170 150 120	280 250 220 170
100 (and 125 Ortho)	1/25† 1/50 1/100 1/200	240 220 190 140	350 320 270 210

To calculate the *f*/number divide the guide number by the distance *in feet* between lamp and subject and select the nearest aperture stop or half way position.

† *Same guide number holds for open-flash technique.*

NOTE: Full data for the M 5 lamp has not been worked out. It has about the same lighting effect as the No. 5 lamp at speeds up to 1/50 second. It is about 1/2 as bright at 1/100 to 1/500 second.

parency illuminator should always be employed for the subsequent comparison of serial records

In spite of having somewhat less exposure latitude than black and white films color films are easier to use in medical photography This is not often appreciated. But the fact is that it requires considerable skill to render color values graphically in terms of the gray variations of a black and white print Color photography on the other hand, provides the benefits of color

differentiation and thus simplifies delineation.

Of course in concerted studies of morphology or posture, color films are not needed. *Occasional studies of this nature* however for insertion into collections of other types of color records, are best made on color films. In this way distracting transitions from color to black-and-white do not occur in a presentation of the cases.

Types of Color Films

There are two major kinds of color films that the medical photographer will be concerned with. *The distinction involved lies* in the processing—one type can be processed by the photographer or in photofinishing plants, the other by the manufacturer or in specialized photofinishing laboratories. Useful positive films and their day-and artificial light exposure *indexes* are as follows.

Films in the first category are ROLL, MINIATURE ROLL—Anscochrome, 32,—*Super Anscochrome* 100 80- Ektachrome, 32, 16(F) SHEET—Anscochrome, 32, 25 Ektachrome 12, 10 These are for use in daylight or 3200 K (*type B film*) illumination. In the second category are 35-millimeter and Bantam Kodachrome Films. Daylight, index 10 and Type F index 12, for photoflash illumination

Kodachrome Professional Film, Type A (index 16, for photoflood illumination) is only produced *in* 35-millimeter 36-exposure rolls. The other 35-millimeter films

"K" stands for Kelvin, and this figure indicates the color-temperature of the source. The spectral quality of the light here is that of a perfect radiator burning at a temperature of 3200 on the Kelvin scale of temperature

TABLE VII

PHOTOFLASH LAMP GUIDE EXPOSURE NUMBERS FOR CLOSE-UP PHOTOGRAPHY

(Given for bare lamps without reflectors, or in blackened ones, and for distances in inches)

EXPOSURE SPEED	SHUTTER SPEED	GUIDE NUMBERS* FOR LAMPS SHOWN		
		No. 5 or No. 25	No. 22 or No. 2	M 5
12 16	1/25† 1/100 1/200 1/400	336 275 240 180	490 410 336 240	236 210 155 125
20	1/25† 1/100 1/200 1/400	384 324 264 192	528 444 384 264	384 240 190 145

* To calculate the f/number divide the guide number by the distance in inches between lamp and subject and select the nearest aperture stop or half-way position.

† Same guide number holds for open-flash technique.

are available in 20- or 36-exposure rolls Bantam films have 8 exposures

Color films can be further separated into two classes : those that provide positive color transparencies direct (above) and color negative films From the latter it is possible to print any number of various types of final photographs—miniature and large transparencies color prints and black and white prints

Kodacolor Film (miniature and roll, only) *is a universal color negative film that* can be exposed under daylight, electronic flash or clear photoflash illumination Kodacolor prints are made by the Eastman Kodak Company and these provide an economical program for those utilizing the simplified techniques

Ektacolor Film is a negative color sheet film It is available for medical photography as Type S for electronic flash lamps and Type B

All negative color films can be processed by the photographer or in photofinishing plants Kodacolor Film will also be processed *by the manufacturer*

Color negatives, including Kodacolor negatives, can be printed on Kodak Ektacolor Paper to provide color prints This can be done with direct development by the experienced photographer

The contrast of any color films processed by the *photographer* cannot be controlled nearly to the extent of black and white films, although there is a very slight range possible Kodachrome Films have a fixed contrast which is somewhat higher than that obtainable with the other color films. *Sometimes this* higher contrast is necessary to give emphasis to faint lesions for greater clarity

While any of the color films described will serve in the photography of patients, it is worth noting the special potentialities of color negative and print films A color negative film reproduces the image in complementary colors as well as in nega*tive tone values. Like black-and white* negatives, the resulting "transparency" must then be printed to form a final photograph A single color negative can be kept in the files and final photographs made for specific needs as they arise

This can be done on a sheet printing *film for large positive transparencies* (Ektacolor Print Film) by the photographer Ektacolor Slide Film available in 100-foot 35mm rolls (perforated or unperforated) can be utilized for making positive miniature transparencies from any color negative It too can be processed by the photographer

Kodacolor and other color negatives can be printed on Ektacolor Paper to provide direct color prints. And Kodak Panalure Paper is especially designed for making black and white prints by contact or enlarging from color negatives

Illumination for Color Films

Lighting of the correct color quality is necessary for use with color films. The in

door roll films require light of photoflash quality (except Type A film, which is for photoflood lamps) whereas the sheet films are designed for 3200°K illumination. The light balancing filters can be employed to adapt a film from one of these lightings to another in emergencies. Full details are given in the instructions for each film. Electronic flash units require the use of daylight films.

Duplicates

Color transparencies can be sent in for duplication by the Eastman Kodak Company or other duplicating laboratories. These can be in larger or smaller sizes than the original. This makes a practical source of large transparencies for display purposes. It also permits the preparation of extra lecture or classroom sets in 3¼ x 4-inch or 2 x 2-inch slides. Many photographic departments make a 3¼ x 4¼-inch master transparency and then have it duplicated for various purposes—6.5 x 9 centimeter and 2¼ x 3¼ inches are good sizes for large lantern slides. In this way originals can be carefully filed and the wear of routine usage taken by the duplicates.

When wanted, black and white negatives can be obtained from positive color transparencies by contact-printing or enlarging them onto a slow panchromatic film. The exposed films should be developed about half the usual time (specifically to a gamma of about 0.5) This will produce a negative with a contrast approximating that which would be obtained from photographing the patient with a black-and-white negative material.

Exposure

Tables V, VI, and VII include exposure data for color films. Moderate care with exposure is required because color films have less exposure latitude than negative materials.

In establishing a technique it is common practice to make a series of exposures varying by a half stop (half of the change between two f/-numbers such as f/8 and f/11) The need for this soon disappears when the photographer becomes familiar with lighting and the characteristics of his equipment.

As a general rule color photography is an easier technique than black-and white photography Of course somewhat more care in exposure is required by the former and when processing is done by the photographer more time is involved.

Lighting by an inexperienced photographer and that offered by the simplified technique is more likely to yield good delineation of the subject in color photography Optimum techniques are more often demanded by black-and-white photography because there is no color only tone to separate details. Good prints are needed for monochrome reproduction in journals so that the textbook illustration needs special care. In spite of all this, it should not be overlooked that the *best* quality color photograph is made by the optimum technique too.

are available in 20- or 36-exposure rolls Bantam films have 8 exposures

Color films can be further separated into two classes those that provide positive color transparencies direct (above) and color negative films From the latter it is possible to print any number of various types of final photographs—miniature and large transparencies color prints and black and white prints

Kodacolor Film (miniature and roll, only) is a universal color negative film that can be exposed under daylight, electronic flash or clear photoflash illumination Kodacolor prints are made by the Eastman Kodak Company and these provide an economical program for those utilizing the simplified techniques

Ektacolor Film is a negative color sheet film It is available for medical photography as Type S for electronic flash lamps, and Type B

All negative color films can be processed by the photographer or in photofinishing plants Kodacolor Film will also be processed by the manufacturer

Color negatives, including Kodacolor negatives, can be printed on Kodak Ektacolor Paper to provide color prints This can be done with direct development by the experienced photographer

The contrast of any color films processed by the photographer cannot be controlled nearly to the extent of black and white films although there is a very slight range possible Kodachrome Films have a fixed contrast which is somewhat higher than that obtainable with the other color films Sometimes this higher contrast is necessary to give emphasis to faint lesions for greater clarity

While any of the color films described will serve in the photography of patients, it is worth noting the special potentialities of color negative and print films. A color negative film reproduces the image in complementary colors as well as in negative tone values. Like black-and white negatives the resulting "transparency" must then be printed to form a final photograph A single color negative can be kept in the files and final photographs made for specific needs as they arise

This can be done on a sheet printing film for large positive transparencies (Ekta color Print Film) by the photographer Ektacolor Slide Film available in 100-foot 35mm rolls (perforated or unperforated) can be utilized for making positive miniature transparencies from any color negative It too can be processed by the photographer

Kodacolor and other color negatives can be printed on Ektacolor Paper to provide direct color prints And Kodak Panalure Paper is especially designed for making black and white prints by contact or enlarging from color negatives.

Illumination for Color Films

Lighting of the correct color quality is necessary for use with color films The in

door roll films require light of photoflash quality (except Type A film, which is for photoflood lamps) whereas the sheet films are designed for 3200°K illumination. The light balancing filters can be employed to adapt a film from one of these lightings to another in emergencies. Full details are given in the instructions for each film. Electronic flash units require the use of daylight films.

Duplicates

Color transparencies can be sent in for duplication by the Eastman Kodak Company or other duplicating laboratories. These can be in larger or smaller sizes than the original. This makes a practical source of large transparencies for display purposes. It also permits the preparation of extra lecture or classroom sets in 3¼ x 4-inch or 2 x 2-inch slides. Many photographic departments make a 3¼ x 4¼-inch master transparency and then have it duplicated for various purposes—6.5 x 9 centimeter and 2¼ x 3¼ inches are good sizes for large lantern slides. In this way originals can be carefully filed and the wear of routine usage taken by the duplicates.

When wanted, black-and-white negatives can be obtained from positive color transparencies by contact-printing or enlarging them onto a slow panchromatic film. The exposed films should be developed about half the usual time (specifically to a gamma of about 0.5). This will produce a negative with a contrast approximating that which would be obtained from photographing the patient with a black-and-white negative material.

Exposure

Tables V, VI, and VII include exposure data for color films. Moderate care with exposure is required because color films have less exposure latitude than negative materials.

In establishing a technique it is common practice to make a series of exposures varying by a half stop (half of the change between two f/-numbers such as f/8 and f/11). The need for this soon disappears when the photographer becomes familiar with lighting and the characteristics of his equipment.

As a general rule color photography is an easier technique than black-and-white photography. Of course somewhat more care in exposure is required by the former and when processing is done by the photographer more time is involved.

Lighting by an inexperienced photographer and that offered by the simplified technique is more likely to yield good delineation of the subject in color photography. Optimum techniques are more often demanded by black-and-white photography because there is no color, only tone, to separate details. Good prints are needed for monochrome reproduction in journals so that the textbook illustration needs special care. In spite of all this, it should not be overlooked that the *best* quality color photograph is made by the optimum technique too.

CHAPTER VIII PRINTING METHODS

THE PRINCIPLES of black-and white photographic printing are readily grasped yet their application is no casual matter Simple as the steps involved are, each must be done carefully in order that the quality attained in the negative may be fully realized when prints are made. It is beyond the scope of this book to go into color printing Much of the work in the medical field can be done by specialized laboratories It is sufficient to say here that black and white printing should be thoroughly mastered before color printing is attempted Kodak Panalure Paper for making black and white prints from color negatives is handled like enlarging paper

The making of good prints has two essential phases the actual process of printing and developing and the judging of print quality The purpose of this book is to bring to the readers attention helpful suggestions and precautions that will, if followed, ensure excellent prints. This chapter deals with the fine points of print making it assumes that the worker is at least familiar with the general procedure and operation of necessary equipment. Chapter IX will be devoted to a discussion of how to select a paper of suitable surface and contrast for a given negative and to judge the contrast and density of prints and other aspects of print quality

Handling Equipment

In order to produce prints of high quality adequate equipment must be employed It is also important that the apparatus be properly adjusted

THE CONTACT PRINTER

The contact printer most frequently used for medical photography is the box printer that incorporates an adjustable ground glass shelf for diffusing the illumination and for dodging. Accordingly the following recommendations are based on this type although they are easily applicable to others

For best results a printer must provide close contact between the negative and the

Dodging will be discussed fully in Chapter IX.

photographic paper; otherwise definition and brilliance of the prints suffer. Therefore steps that appear necessary should be taken to improve the contact in any worn equipment. Sometimes the masking blades, especially if buckled, cause poor definition at the edges of the prints. The blades should be flattened and, if the trouble persists, it is often helpful to place the negative on top of them instead of underneath. The masking blades should be trued if print margins are out of square.

The glass under the platen must be cleaned before the work is begun. Dust is best removed from glass surfaces with a soft brush because polishing them with a cloth only attracts lint. The negative itself should also be dusted with a brush.

If the diffusing glass is removed for cleaning, care should be taken to replace it exactly in its original position; otherwise direct light may flare from a gap in the rear to cause uneven image density on the prints. If the lamps are not all alike in wattage and type or if they are not all lighted, the resulting illumination of the platen also causes uneven exposure.

THE ENLARGER

Most enlargers are equipped with masking devices. Their use should never be neglected because stray light from around the edges of the negative seriously affects the quality of an enlargement. It causes overall fog and lack of brilliance in the highlights.

Glass elements in negative carriers, lenses, condensers, and ventilation systems require attention. Most photographers habitually clean the glass in the negative carrier before using the enlarger because dirt on it produces obvious defects in the prints. Yet few make a habit of inspecting the lens for dust or fingerprints, which produce a puzzling lack of brilliance and sharpness in the prints that is usually not traced to the correct source at once (see Figure 1). The other glass elements of the enlarger need occasional cleaning too, since dust on them may drop off onto the negative carrier or the lens.

The lens should be cleaned by polishing it with lens tissue or dusting it with a sable brush. The same considerations given for cleaning glass in the contact printer apply to the other glass surfaces in the enlarger. When not in use an enlarger should always be protected with a dust cover to minimize the necessity for cleaning.

A fault sometimes encountered results from unevenness in the illumination; this may be due to various causes. If enlargements show markedly light corners, the effect may be traceable to one or more of the following, depending on the design of the enlarger. The lamp may not be the one recommended for the enlarger, or it may not be correctly located; the lens may be stopped down to an excessively small aperture; the interchangeable condenser may not be the proper one for the lens in use; the inside of the reflecting hood may require dusting with a soft brush, or the

Figure VIII 1 Comparison of enlargements to show poor quality resulting from the use of dusty enlarger lens and improvement obtained by projecting through cleaned lens (Photograph was made to visualize extensive keratosis) *A* Print exposed through lens having a thin coat of dust on upper surface *B* Print exposed after lens was cleaned When viewed with *B* covered *A* does not appear to be markedly poor in quality; yet when compared with *B* *A* s worthless ness in depicting keratosis irregularities is obvious; even the freckles are barely apparent

shiny surface may be tarnished badly in which case the advice of the manufacturer should be sought regarding resurfacing it Another illumination defect appears as a streak across the print and may be due to a cracked condenser lens or glass in the ventilation system

The attainment of maximum sharpness is obviously desirable Therefore the en larger and its support should be rigid and not subject to vibrations from traffic and elevators It is also necessary to focus the enlarger lens accurately This should be done with the lens wide open for two rea sons First the brightness of the projected image is such that fine detail can easily be seen Second, slight movements of the focusing knob from the position of sharp focus are quite noticeable because the depth of focus is not great By focusing the lens

at an aperture greater than the desired one, it is possible to decrease the aperture by one or two stops and thus increase the depth of focus to offset slight inaccuracies of focus that are sometimes difficult to perceive.

Handling Photographic Paper

Although photographic papers do not have the extreme sensitivity to light that films possess, some precautions are required in using them. It is necessary to provide as much visibility in the darkroom as possible so that prints can be judged for density and contrast during processing; nevertheless, excessive and unsafe illumination from safelight lamps must be avoided. Lamps with safelights of suitable color should be installed at recommended working distances and bulbs of specified wattage must be utilized.

Since safelights may deteriorate with age or from the inadvertent use of too large a bulb, they should be tested occasionally. This can be accomplished by exposing to their illumination, at recommended lamp-to-paper distances, a sheet of photographic paper partially covered with black paper. The photographic paper should be exposed for a time that takes into account the maximum period required for every printing operation—cutting, exposing, dodging, and so forth. After development, if a line of demarcation appears between the covered and uncovered areas, the illumination is not safe.

Both enlarging and contact printing papers can be handled under the same safelights if those suitable for the more sensitive enlarging paper are employed (such as the Kodak Wratten OA). This, of course, furnishes illumination of adequate visibility for working with contact printing papers even though not of the maximum intensity that most of them can tolerate. An additional safelight of the appropriate type provides greater convenience in contact printing.

Another point that should be borne in mind is that photographic paper is susceptible to fingerprints until it has been in the developer for a second or so. Again, finger mark stains result if the paper is held by the same corner or edge throughout development.

Exposure

The exposure should always be gauged so that the desired density can be obtained in the print upon recommended development. The skilled worker can usually estimate the exposure time from a mere appraisal of the negative. The less experienced should make exposure tests on a strip of the paper to be employed, using an estimated time as a basis. In order to obtain usefully noticeable differences on the test strip it is necessary to vary the exposure steps by a factor of at least two. For instance, when an exposure of 6 seconds is estimated, different sections of the strip should be given exposures of 3, 6, and 12

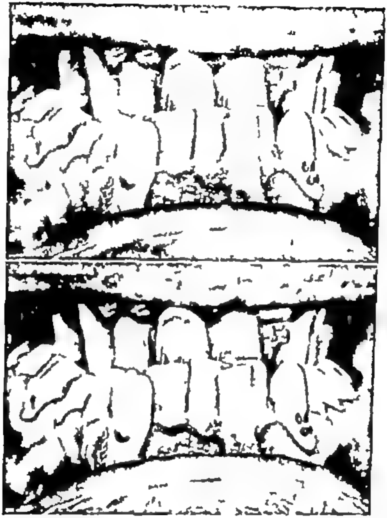


Figure VIII-2: Effect of development on quality of print and clarity of subject *A* Print removed prematurely from developer to avoid excessive density from overexposure; *B* Print given correct exposure and full development Note that detail modeling and natural gradations apparent in dark areas of *B* are indistinct in the muddy short scale print *A*

seconds The variations in image density so obtained usually suffice as a guide to the correct exposure time since one of the areas will either represent the correct exposure time or indicate the need for an intermediate exposure (*If test exposures of 5 6 and 7 seconds were given there would not be enough variation in density or suffi*

cient range to gauge the correct exposures.) If a print has been made with a given exposure and others somewhat darker or lighter are desired, the original exposure should be increased or decreased by a factor of about 1.5 for normal papers and by about 1.2 for contrasty papers.

When an enlarger is employed, test strips can be easily made by intercepting portions of the projected image with a sheet of black paper held close to the photographic paper. The entire sheet should be given ¼ of a guessed exposure—let us say that this overall exposure is 2 seconds. Then the first step should be covered and the rest given *2 seconds again*. From then on, the remainder after each step is covered is given a doubled exposure thus: 2, 2, and then 4, 8, 16. The result is steps having 2, 4, 8, 16 and 32 seconds exposure, 8 seconds being the guessed time. It is also possible to make stepped test strips in a contact printer (although many prefer to make single-exposure tests). The negative and paper should be held along one edge by means of the rear portion of the split platen. Then, after raising only the front portion of the platen, a clean, grit free sheet of black paper should be slipped between the negative and the printing paper and moved to cover the steps for the various exposures.

Under some circumstances it is feasible to arrive at the desired exposure by making one or more single-exposure test strips. For example, a stepped strip may have little significance when an enlarged image contains a small but particularly important area that requires careful testing. Again, if the platen on the contact printer has only moderate pressure until locked, or if small negatives are used, single test strips are easier to make than a stepped strip.

Test strips must be given the same processing that is recommended for the final prints; otherwise the test is not valid. Light areas appear slightly darker when the print is dry than they do when the paper is wet, so it is necessary to allow for this effect. The areas in the test strip should be large enough to permit a rough check on the suitability of the grade of paper selected.

Processing

Making a photographic print of the highest quality is as exacting a procedure as carrying out any laboratory reaction. Accordingly the steps involved in printing require just as much care to ensure that each reagent completes its function. A careful darkroom technique saves time and material.

Developing

Manufacturers of photographic papers have conducted extensive research in compounding developers for various types of paper and also in determining optimum development times. Prints should always be developed in accordance with manufacturers instructions.

If a print is not developed for a suffi-

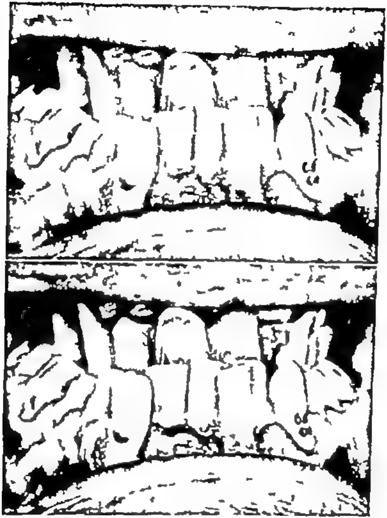


Figure VIII-2: Effect of development on quality of print and clarity of subject *A* Print removed prematurely from developer to avoid excessive density from overexposure; *B* Print given correct exposure and full development Note that detail modeling and natural gradations apparent in dark areas of *B* are indistinct in the muddy short scale print *A*

seconds. The variations in image density so obtained usually suffice as a guide to the correct exposure time since one of the areas will either represent the correct exposure time or indicate the need for an intermediate exposure (If test exposures of 5 6 and 7 seconds were given, there would not be enough variation in density or suffi

RINSING

The use of a rinse or "stop" bath is an essential step, although one whose importance is too often overlooked. Its purpose is to arrest development and rinse off the adhering developer that would contaminate and reduce the efficiency of the fixer. Prints should be given this treatment as soon as development is completed with agitation in the bath for at least five seconds. There should be no pause for the purpose of inspecting the image before immersion of the print because exposure to the air before fixation might cause oxidation stains. There is also danger of fog resulting from proximity to the safelight.

The concentration of the stop bath and the rinsing time should be carefully regulated. If the bath is excessively acid, or if prints are allowed to accumulate in the tray before fixing, mottled areas and stains may ensue. A weak stop bath or insufficient rinsing, on the other hand, incompletely neutralizes the developer chemicals.

FIXING

The photographer is often so engrossed in carrying prints through the stages of suitable development that he is apt to treat the fixing tray as a repository for the prints until a convenient time arrives for washing them. This must be avoided because the silver image itself becomes appreciably reduced once the unaffected silver halide grains in the emulsion are dissolved by the hypo. This results in bleached highlights and tone changes in the images. Again, the fibers of the paper base become highly impregnated with fixing salts upon prolonged fixing, making it difficult to wash the prints thoroughly.

Fixers, like other processing solutions, become exhausted with use and incapable of complete action. Undissolved light-sensitive crystals then remain in the prints, eventually causing stain and fog, and hardening agents can no longer minimize softening of the print emulsion. Testing outfits are available for checking rinsing and fixing baths.

After a fixer has been in use for some time a whitish sludge may form on the bottom of the tray. This is an indication that at least the hardening agent has deteriorated. Accordingly, a sludged fixing solution should be discarded.

Strong fixing solutions intended for films—x-ray fixers, for example—should not be used for prints since they make it difficult to wash the paper base thoroughly. Also the prints are likely to dry brittle. Fixing solutions of moderate strength that have been used for fixing negatives are not suitable for prints because stains may occur. Prints should always be fixed for the times recommended by the manufacturer to ensure removal of the undeveloped light-sensitive crystals.

WASHING

To assure reasonable permanence of the

ciently long period, for example, when it is prematurely removed from the developer in an effort to correct over-exposure, the dark tones appear weak, foggy and possibly greenish The effect, usually called "muddiness" is demonstrated in Figure 2 Overdevelopment, on the other hand may cause oxidation stains and developer fog Uneven development causes streaks and mottled areas therefore, the print should be immersed rapidly and the tray rocked almost continuously

The depth of the solution should be ample (about one-half inch) so that as little air as possible will reach the print In this way one of the possible sources of uneven development and stains due to aerial oxidation is precluded

Only reasonably fresh solutions should be used because stains fog, and muddiness are likely to occur if solutions that have deteriorated from age are employed In storing stock developer solutions it is wise to fill the bottle completely because air above the liquid oxidizes and thus ages the active ingredients For solutions that are not used up within a reasonably short period it is well to mix only small quantities and to store them in small bottles Another possible source of stains and muddiness is the use of an exhausted developer solution or of one that has become contaminated with the fixer

It is necessary to use the developer at approximately the recommended temperature. If the solution is too warm fog and stain are likely to ensue On the other hand, a developer that is too cold necessitates an unduly long development time and also makes it impossible to utilize fully the inherent qualities of the paper The surest way *to avoid these effects is to employ* a thermometer to check the temperature and regulate it accordingly

The cardinal rule in printing is to make exposures that suit recommended development and not to vary development unduly to accommodate the exposures However it is impossible to avoid some inaccuracies in timing or estimating exposures, or fluctuations in lamp intensity due to voltage variation For these reasons, most papers have liberal processing latitudes The recommended developing time given for these *papers in the literature and instructions* should be adopted as a standard the tolerable minimum and maximum times given represent the range over which slight variances in exposures can be adjusted for Such limits should never be exceeded

The tone—the degree of brownishness or "warmth"—of the image depends somewhat upon the developer used *One that yields* a neutral black on commonly employed papers is recommended for general use in medical photography and particularly for prints intended for photomechanical reproduction Warmer image tones are produced by other developers, especially on certain papers (The types of subject for which warmth may be preferred will be covered in Chapter IX)

Rinsing

The use of a rinse or "stop" bath is an essential step, although one whose importance is too often overlooked. Its purpose is to arrest development and rinse off the adhering developer that would contaminate and reduce the efficiency of the fixer. Prints should be given this treatment as soon as development is completed with agitation in the bath for at least five seconds. There should be no pause for the purpose of inspecting the image before immersion of the print because exposure to the air before fixation might cause oxidation stains. There is also danger of fog resulting from proximity to the safelight.

The concentration of the stop bath and the rinsing time should be carefully regulated. If the bath is excessively acid or if prints are allowed to accumulate in the tray before fixing, mottled areas and stains can occur. A weak stop bath or insufficient rinsing, on the other hand, incompletely neutralizes the developer chemicals.

Fixing

The photographer is often so engrossed in carrying prints through the stages of suitable development that he is apt to treat the fixing tray as a repository for the prints until a convenient time arrives for washing them. This must be avoided because the silver image itself becomes appreciably reduced once the unaffected silver halide grains in the emulsion are dissolved by the hypo. This results in bleached highlights and tone changes in the images. Again, the fibers of the paper base become highly impregnated with fixing salts upon prolonged fixing, making it difficult to wash the prints thoroughly.

Fixers, like other processing solutions, become exhausted with use and incapable of complete action. Undissolved light-sensitive crystals then remain in the prints, eventually causing stain and fog, and hardening agents can no longer minimize softening of the print emulsion. Testing outfits are available for checking rinsing and fixing baths.

After a fixer has been in use for some time, a whitish sludge may form on the bottom of the tray. This is an indication that at least the hardening agent has deteriorated. Accordingly, a sludged fixing solution should be discarded.

Strong fixing solutions intended for films—x-ray fixers, for example—should not be used for prints since they make it difficult to wash the paper base thoroughly. Also the prints are likely to dry brittle. Fixing solutions of moderate strength that have been used for fixing negatives are not suitable for prints because stains may occur. Prints should always be fixed for the times recommended by the manufacturer to ensure removal of the undeveloped light-sensitive crystals.

Washing

To assure reasonable permanence of the

ciently *long period* for example, when it is prematurely removed from the developer in an effort to correct over-exposure, *the dark tones* appear weak, *foggy,* and possibly greenish The effect, usually called "muddiness" is demonstrated in Figure 2. *Overdevelopment, on the other* hand may cause oxidation stains and developer fog Uneven development causes streaks and mottled areas, therefore, the print should be immersed rapidly and the tray rocked almost continuously

The depth of the solution should be ample (about one-half inch) so that as little air as possible will reach the print in this way one of the possible sources of uneven development and stains due to aerial oxidation is precluded

Only reasonably fresh solutions should be used because stains, fog, and muddiness are likely to occur if solutions that have deteriorated from age are employed In storing stock developer solutions it is wise to fill the bottle completely because air above the liquid oxidizes, and thus ages, the active ingredients For solutions that are not used up within a reasonably short period it is well to mix only small quantities and to store them *in small bottles* Another possible source of stains and muddiness is the use of an exhausted developer *solution or of one* that has become contaminated with the fixer

It is necessary to use the developer at *approximately* the recommended temperature If the solution is too warm, fog and stain are likely to ensue On the other hand, a developer that is too cold necessitates an unduly long development time and also makes it *impossible* to utilize fully the inherent qualities of the paper The surest way to avoid these effects is to employ a *thermometer* to check the temperature, and regulate it accordingly

The cardinal rule in printing is to make exposures that suit recommended development and not to vary development unduly to accommodate the exposures However it is impossible to avoid some inaccuracies in timing or estimating exposures, or fluctuations in lamp intensity due to voltage variation For these reasons, most papers have liberal processing latitudes The recommended developing time given for these papers in the literature and instructions should be adopted as a standard the tolerable minimum and maximum times given represent the range over which slight variances in exposures can be adjusted for Such limits should never be exceeded

The tone—the degree of brownishness or "warmth"—of the image depends somewhat upon the developer used One that yields a neutral black on commonly employed *papers is recommended for general use in* medical photography and particularly for prints intended for photomechanical reproduction Warmer image tones are produced by other developers, especially on certain papers. (The types of subject for which warmth may be preferred will be covered in Chapter IX)

RINSING

The use of a rinse or "stop" bath is an essential step, although one whose importance is too often overlooked. Its purpose is to arrest development and rinse off the adhering developer that would contaminate and reduce the efficiency of the fixer. Prints should be given this treatment as soon as development is completed with agitation in the bath for at least five seconds. There should be no pause for the purpose of inspecting the image before immersion of the print because exposure to the air before fixation might cause oxidation stains. There is also danger of fog resulting from proximity to the safelight.

The concentration of the stop bath and the rinsing time should be carefully regulated. If the bath is excessively acid, or if prints are allowed to accumulate in the tray before fixing, mottled areas and stains may ensue. A weak stop bath or insufficient rinsing, on the other hand, incompletely neutralizes the developer chemicals.

FIXING

The photographer is often so engrossed in carrying prints through the stages of suitable development that he is apt to treat the fixing tray as a repository for the prints until a convenient time arrives for washing them. This must be avoided because the silver image itself becomes appreciably reduced once the unaffected silver halide grains in the emulsion are dissolved by the hypo. This results in bleached highlights and tone changes in the images. Again, the fibers of the paper base become highly impregnated with fixing salts upon prolonged fixing, making it difficult to wash the prints thoroughly.

Fixers, like other processing solutions, become exhausted with use and incapable of complete action. Undissolved light-sensitive crystals then remain in the prints, eventually causing stain and fog, and hardening agents can no longer minimize softening of the print emulsion. Testing outfits are available for checking rinsing and fixing baths.

After a fixer has been in use for some time a whitish sludge may form on the bottom of the tray. This is an indication that at least the hardening agent has deteriorated. Accordingly, a sludged fixing solution should be discarded.

Strong fixing solutions intended for films—x-ray fixers, for example—should not be used for prints since they make it difficult to wash the paper base thoroughly. Also the prints are likely to dry brittle. Fixing solutions of moderate strength that have been used for fixing negatives are not suitable for prints because stains may occur. Prints should always be fixed for the times recommended by the manufacturer to ensure removal of the undeveloped light-sensitive crystals.

WASHING

To assure reasonable permanence of the

image it is necessary to remove as much as possible of the residual hypo* from the emulsion. Washing should not be entrusted to haphazard methods single-weight prints should be washed for at least an hour and double-weight prints, two hours, in running water so circulated that both sides receive frequent changes When they are washed in a tray they should not be allowed to form a clump For maximum efficiency the bulk of the hypo should be removed by first rinsing prints in a separate tray of water Washing should be timed from the immersion of the last print since unwashed prints contaminate those partially washed.

The temperature of the wash water is also an important factor because water that is too cold does not sufficiently remove the hypo in the emulsion and paper fibers, even with prolonged washing. On the other hand, water that is too warm is likely to soften the emulsion and cause damage to the image A temperature range from 65°F to 75 F is desirable

Drying

After a print has been washed it should be lightly swabbed with a wet sponge or cotton to remove the scum that is usually present. It is best to do this in the wash tray or on a drainboard under a stream of water to minimize the effects of grit that may be in the water—particularly if the supply is unfiltered The print should be then wiped free of water to hasten drying.

Obviously the drying facilities should be clean to avoid contamination of the prints which may cause stains and fading Prints must be dried free from troublesome wrinkling and curling to lessen the possibility of physical damage when they are handled This can be accomplished by drying them between blotters, with or without pressure. Only blotters made especially for photographic use should be employed for drying prints others may contain harmful chemicals that would cause deterioration of the print When drying racks are used it is sometimes necessary to straighten the prints after they have dried by dampening the backs with a solution of 50 per cent methyl alcohol in water and then stacking them between blotters under heavy pressure

When prints on glossy paper are to be ferrotyped, it is essential to use clean highly polished plates to preclude damage from sticking Firm even pressure is required in squeegeeing the prints to the plate otherwise dull spots may appear where small areas were out of contact

* In this connection, the word "hypo" is used as a general term to include any of the fixing chemicals that, when retained in the print, would lead to fading of the silver image

CHAPTER IX PAPER SELECTION, QUALITY CONTROL AND PRINT QUALITY

Once the manual operations of print making have been mastered, they become automatic. The photographer can then concentrate on the matter of getting prints of the best possible quality from his negatives.

An excellent print should show a full tone range from black to almost white and have tone gradations that create an effective mental impression of the original subject. In practical terms, an excellent print is one that cannot be improved upon by printing the negative on a different paper or by giving a different exposure on the same paper or by changing the processing.

In order to obtain this ideal, judgment is important in selecting a type of paper with the most suitable physical characteristics in choosing a paper with the correct photographic characteristics and in evaluating the density range of the negative.

Physical Characteristics

The physical characteristics of a photographic paper include its surface texture and sheen, weight and flexibility tint and image tone. A wide range of combinations of these characteristics is offered, and at first glance it might seem difficult to select the most appropriate paper for a given medical photograph. The problem becomes relatively simple however if the physical characteristics are considered in the following order

Surface Texture and Sheen

Maximum definition and clarity of detail are essential in medical photographs. These objectives are best achieved by using a paper with a smooth surface and a high sheen or gloss. When prints on this surface are dried on ferrotype plates, they have an extremely smooth, enamel-like surface that imparts additional brilliance

For large prints that are to be used in the classroom and for educational displays of various types, some photographers prefer a paper with a slightly rough surface. They have a fine-grained texture with good lustre without extreme glossiness.

Weight and Flexibility

These characteristics are closely associated and should be considered together Weight refers to the thickness of the paper stock Papers are supplied in two weights—Single and Double The Double Weight paper is stiffer than the Single Weight and is, therefore, more suitable for prints larger than 8 x 10 inches For smaller prints and those that are to be ferrotyped Single Weight is preferred

Some papers are especially made for prints that are to be mailed and do not crack when folded They yield a print with a high durability and strength that recommend it for instruction sheets file cards, notebook inserts and in fact, any application in which a photographic print is likely to be subjected to much handling

Tint

The term tint describes the color of the paper stock For medical illustration the white stock should be selected Cream white may however prove useful for exhibition prints of a more or less pictorial nature as in the public relations field

Image Tone

Image tone refers to the color of the silver image as it appears on the paper Some papers produce a cold tone image and others a warm black one A cold tone image is generally preferred for scientific illustration and for prints to be reproduced by photomechanical processes A warm-tone paper should be restricted to printing for display purposes

Materials appropriate for a number of specific applications in medical photography are given in Table VIII

Photographic Characteristics

While selection of a type of paper with suitable physical characteristics depends on the intended use of the photographic print the selection of a paper with correct photographic characteristics depends upon the printing method to be employed and the contrast of the negative

Printing Speed

Illumination levels used in enlarging are usually much lower than in contact printing. Therefore it is desirable to use for each class of work a paper with a speed that will result in a convenient exposure time—i e., one short enough to be practical yet long enough to be easily controlled With this in mind the recommendations in Table VIII have been made under the two classifications "Enlarging" and "Contact Printing." It will be noted that some papers are useful in both purposes because they are of moderate speed and can be used for contact printing by reducing the intensity of the printing light and with enlargers that provide adequate illumination Enlargements made at high magnification require a fast paper because of the reduction in image brightness involved

TABLE VIII

PHOTOGRAPHIC PAPERS FOR BLACK-AND-WHITE MEDICAL PHOTOGRAPHY

APPLICATION	ANSCO		DU PONT	HALOID		KODAK	
	Enlarging	Contact	Enlarging	Enlarging	Contact	Enlarging	Contact
Institutional and Offic Records	Convira Glossy	Convira Glossy	Velour Black T	Halobrome FF	Industro F	Medalist F	Azo F
Medicolegal use	Convira Glossy	Convira Glossy	Velour Black T	Halobrome FF	Industro F	Medalist F	Azo F
File and Notebook Prints, folding and mailing			Velour Black AL	Outline Bromide	Industro Outline	Kodabromide A	Ad-Type A
Illustrations for Publications (Ferrotyped)	Convira Glossy	Convira Glossy	Velour Black R	Halobrome F	Industro F	Medalist F	Azo F*
Convention and Educational Display, Classroom and Staff Meeting Visual Aids	Indiatone Kashmir Jet	Convira Glossy	Velour Black T & DS or Varation DL	Halobrome FF & GG or Portraye GG	Industro F	Medalist Kodabromide J F & G or Opal G	Azo F*
For Showing by Transillumination	—	—	Adlux Film	—	—	Translite Film	Translite Film
See Note Below**			Varigam	Varaloid	Halex	Polycontrast Rapid Polycontrast	Polycontrast

These are not all the papers that could be used in the field but rather this is a simple selection given to indicate basic needs.

When a large number of prints are made many departments use these papers. They yield several grades of contrast through a series of color filters that can be placed over the enlarger lens. For contact printing, large acetate filters, up to 11 x 14 inches in size are available.

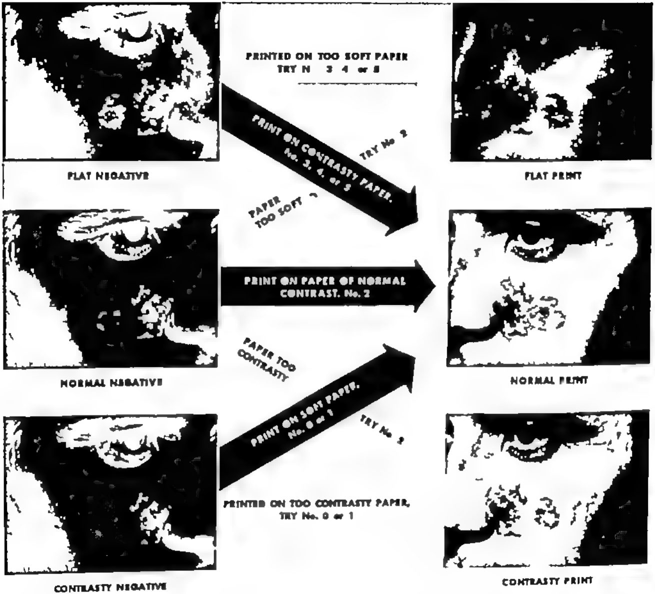


Figure IX 1: A paper selection guide To use it first decide which of the illustrated negatives most nearly matches the contrast of the one to be printed Then follow the directions in the black arrow leading from that negative Thus a normal negative should be printed on No 2 paper If prints from a certain negative appear flat or contrasty follow the instructions in the white arrow connecting the illustrations most similar to that print and negative When in doubt try a print on No 2 paper

CONTRAST GRADE

Photographic papers are available in several contrast grades. For example Azo F is supplied in six degrees of contrast—designated by the numbers 0 1, 2, 3, 4, and 5 The purpose of the variety of contrast grades is to compensate the differences in printing quality found in negatives. The problem facing the photographer about to make a print is to select the contrast grade that will yield a print of the desired standard. This requires an ability to judge negative quality Although such skill can be perfected only by actually making prints from negatives on several grades of contrast and analyzing the results, the learning time can be shortened by a proper approach to judging negatives for printing.

Judging Negatives for Printing

The question that arises at this point is On what should the photographer fix his attention when he is inspecting a negative to decide which contrast grade he should use? The answer is that he should evaluate the density range[1] of the negative the *difference* in density between highlight and shadow That is what determines its printing contrast. The average denseness of the negative governed by the exposure given in the camera, is of concern only as it affects the density range It will usually be found that very thin and extremely dense negatives have a limited density range—that is, they are soft or low contrast negatives. Fundamentally however it is the *density difference* that is important in estimating printing contrast.

The negatives and corresponding prints in Figure 1 illustrate how the use of the appropriate contrast grade of printing paper results in prints of similar appearance from negatives differing widely in density range The negative with low contrast or short density range produces a good print on a printing paper with high inherent contrast. Conversely the negative with an extremely great difference between highlight and shadow densities requires a printing paper with a low contrast.

When seeking the best possible print from a given negative one cannot always be sure that success has been attained if prints have been made only on a single contrast grade of paper Figure 2 illustrates this. When all the prints except the one shown in Figure 2A are covered, this one might be considered satisfactory Similarly Figure 2C, when examined alone appears of quite good quality It is only when these prints are compared with an excellent one Figure 2B that their deficiencies become evident. It is then obvious that Figure 2A is lacking brilliance and has weak shadow tones and that Figure 2C is slightly too contrasty The extremely contrasty print, Figure 2D in which the faults of Figure

[1] In sensitometric discussions, this is called the density scale

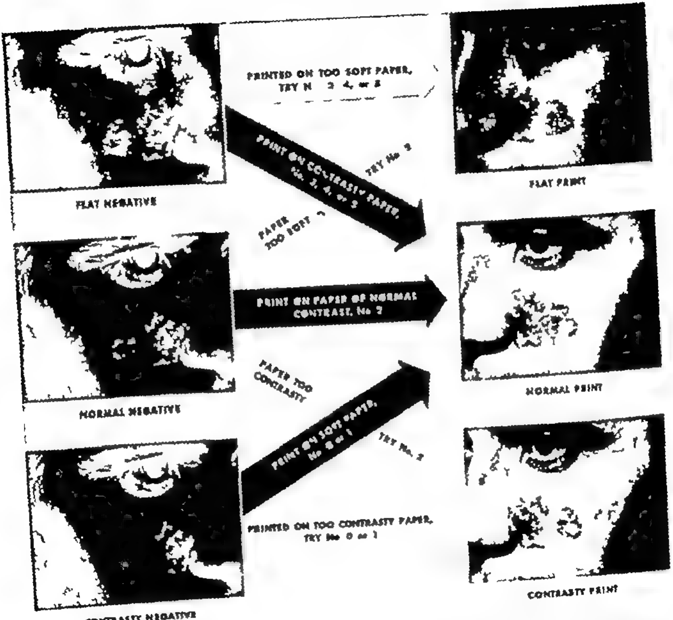


Figure IX 1: A paper selection guide. To use it first decide which of the illustrated negatives most nearly matches the contrast of the one to be printed. Then follow the directions in the black arrow leading from that negative. Thus a normal negative should be printed on No 2 paper. If prints from a certain negative appear flat or contrasty follow the instructions in the white arrow connecting the illustrations most similar to that print and negative. When in doubt try a print on No 2 paper

CONTRAST GRADE

Photographic papers are available in several contrast grades. For example, Azo F is supplied in six degrees of contrast—designated by the numbers 0, 1, 2, 3, 4, and 5. The purpose of the variety of contrast grades is to compensate the differences in printing quality found in negatives. The problem facing the photographer about to make a print is to select the contrast grade that will yield a print of the desired standard. This requires an ability to judge negative quality. Although such skill can be perfected only by actually making prints from negatives on several grades of contrast and analyzing the results, the learning time can be shortened by a proper approach to judging negatives for printing.

Judging Negatives for Printing

The question that arises at this point is: On what should the photographer fix his attention when he is inspecting a negative to decide which contrast grade he should use? The answer is that he should evaluate the density range* of the negative, the *difference* in density between highlight and shadow. That is what determines its *printing contrast*. The average denseness of the negative, governed by the exposure given in the camera, is of concern *only* as it affects the density range. It will usually be found that very thin and extremely dense negatives have a limited density range—that is, they are soft or low contrast negatives. Fundamentally, however, it is the *density difference* that is important in estimating printing contrast.

The negatives and corresponding prints in Figure 1 illustrate how the use of the appropriate contrast grade of printing paper results in prints of similar appearance from negatives differing widely in density range. The negative with low contrast or short density range produces a good print on a printing paper with high inherent contrast. Conversely, the negative with an extremely great difference between highlight and shadow densities requires a printing paper with a low contrast.

When seeking the best possible print from a given negative, one cannot always be sure that success has been attained if prints have been made only on a single contrast grade of paper. Figure 2 illustrates this. When all the prints except the one shown in Figure 2A are covered, this one might be considered satisfactory. Similarly Figure 2C, when examined alone, appears of quite good quality. It is only when these prints are compared with an excellent one, Figure 2B, that their deficiencies become evident. It is then obvious that Figure 2A is lacking brilliance and has weak shadow tones and that Figure 2C is slightly too contrasty. The extremely contrasty print, Figure 2D, in which the faults of Figure

*In sensitometric discussions, this is called the density scale.

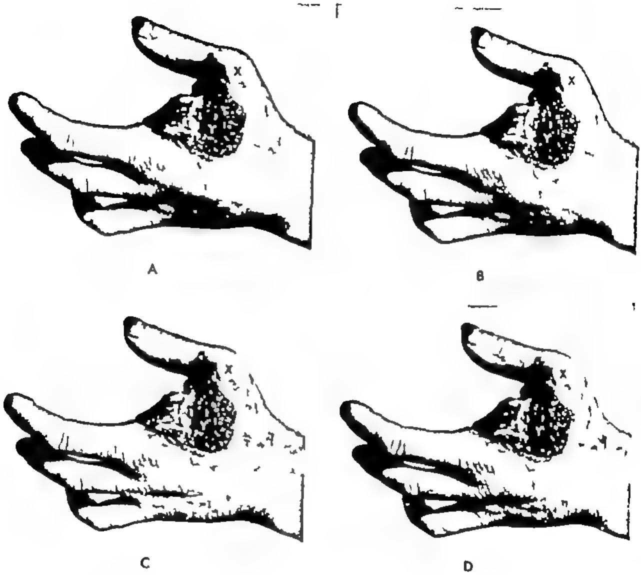


Figure IX 2: A demonstration of the value of making comparison prints These reproductions show the results obtained when a negative is printed on several papers one contrast grade apart Both the slightly soft print *A* and the slightly hard print *C* when viewed alone seem fairly acceptable The superior quality of the correct print *B* becomes apparent only when a comparison is made . Print *D* being one grade more contrasty than print *C* is made too harsh The most important general criterion of the quality of a print is how naturally it depicts the original subject Highlight and shadow areas also provide specific clues to print quality When there is not enough tone difference between them (areas x and y) the print is *soft;* when there is too great a difference (as in prints *C* and *D*) the print is too contrasty and there is usually loss of detail in one or both areas

°C are exaggerated, is included as a guide to areas of the subject that have been impaired by excessive contrast.

This experiment suggests that if doubt exists over the quality of a given print or if the best possible print is to be assured, it is good practice to print also on the two contrast grades adjacent to the one originally selected. The three prints can then be compared and the final choice made

The print on paper of too low a contrast grade will appear "muddy" in comparison with the print of optimum quality. Its blacks will be weak, and fine detail will lack clarity and brilliance. On the other hand, the print on paper of too high a contrast grade will appear "harsh" If the highlight density is correct, shadow detail will be obscured by excessive print density. If the exposure is adjusted to give the desired shadow density the highlight details will be lost. In extreme cases there will be losses in both shadow and highlight.

It might be mentioned that experts with long experience frequently find it necessary to print a negative on paper of several contrast grades to secure a print of the desired quality. The beginner should, therefore recognize the importance of making sure he has selected the correct contrast grade for each negative

Judging Wet Prints

In inspecting the quality of wet prints, it must be kept in mind that when prints dry they lose some of their brilliance. This is most apparent in matte surface papers and least apparent in glossy papers. In learning to estimate this effect or when aiming for the utmost in quality prints may be dried rapidly by sponging off surface moisture and holding them before a fan for a few moments. A print of desired quality can be used as a guide when making additional prints by placing it in the wash water where it can be compared with new prints in the wet state (The reference print should not be kept in the fixing bath, since prolonged immersion will bleach it)

The intensity and color of the illumination used to examine prints for judging quality should approximate the conditions under which they are ordinarily viewed. If the illumination over the wash tray is too bright there will be a tendency to produce prints that are too dark under ordinary room lighting. On the other hand, if the illumination is too dim, the tendency will be toward making prints lacking in strength and vigor. When prints are planned for an exhibit in which they will be viewed under abnormally high or low illumination levels, they should be judged under similar conditions if possible

Local Control

A print of proper density on the correct contrast grade of paper does not always represent the best possible print that can be made from a particular negative For example a photograph may show a large expanse of white sheeting and glaring high-

lights on apparatus and instruments that distract the attention from the area of interest. Although it is desirable to do something about these distractions at the time the picture is made, it is frequently not feasible and therefore an effort should be made to correct them during printing

A preliminary step is to crop carefully In scientific illustration it is advisable to crop closely so that the area of interest occupies the major portion of the picture Only enough of the surroundings should be shown to orient the observer Distracting background detail can often be eliminated in this manner

If the picture still shows bright distracting areas after cropping, local control in printing should be used. This is commonly called dodging, and consists of giving the offending bright areas additional exposure When enlarging, this "printing in" is accomplished by the manipulation of large sheets of black paper in which holes of suitable size have been cut These sheets are held a few inches above the photographic paper in such a position that the objectionable areas are given additional exposure The dodging material should be kept in constant motion to avoid sharp lines of demarcation In contact printing the same effect is achieved by placing tissue paper on the glass shelves beneath the glass supporting the negative. Holes of correct size and shape are cut in the tissues to give additional exposure to desired areas which are positioned over the holes

The dodging procedure just described is used when the print shows local areas that are too light when the major portion of the print is of correct density see Figure 3. When the print is out of balance because certain *small* areas are too dark and the major portion is of desirable density it is better to "hold back" the darker areas than to "print in" the lighter portions. When enlarging this is effected through the use of small paddles made from wire and black paper As in "printing in" the dodging material is kept in motion a few inches above the photographic paper In contact printing the desired areas can be "held back" by penciling the tissue on the glass shelf of the printer or by adding pieces of tissue under the portion of the negative to be printed lighter The tissues can be marked for penciling or cutting by placing them on a sheet of glass laid over the negative on the printer thus making the areas needing modification easy to find

Another application of dodging is in connection with extremely contrasty subjects. When a soft paper is used in an attempt to retain detail in both shadow and highlight portions of negatives from such subjects the fine detail is frequently lost and the highlights have a smoky appearance By printing on more contrasty paper and adjusting the exposure for correct highlight density the condition is corrected so far as the highlights are concerned, but shadow detail is lost By "holding back" the shadows in printing, it is possible to produce a

print from a contrasty subject with good brilliance and detail throughout the scale Dodging should be done carefully to avoid unnatural and obvious modifications.

Print Quality

Summarizing, the main points to be considered in producing highest quality prints for medical illustration are

Use of a white paper with a smooth surface and a neutral black tone for general work.

Selection of Single Weight paper for prints 8 x 10 inches or smaller Double

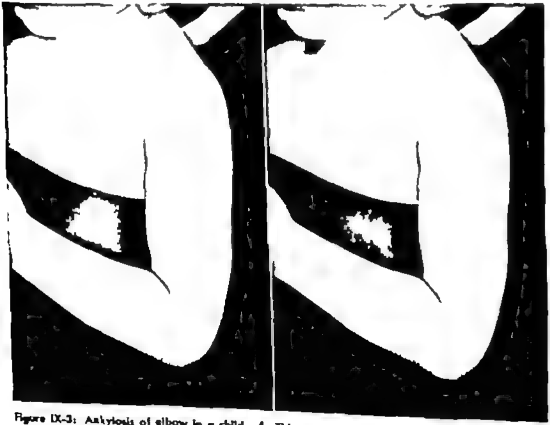


Figure IX-3: Ankylosis of elbow in a child *A* This record was the last one of a series and in making the negative for this aspect the key light was accidentally tipped upwards. The fact was not noted until too late However by dodging duri g printing, *B* it was possible to change the tone values to match other prints in the series

lights on apparatus and instruments that distract the attention from the area of interest Although it is desirable to do something about these distractions at the time the picture is made it is frequently not feasible and therefore an effort should be made to correct them during printing

A preliminary step is to crop carefully In scientific illustration it is advisable to crop closely so that the area of interest occupies the major portion of the picture Only enough of the surroundings should be shown to orient the observer Distracting background detail can often be eliminated in this manner

If the picture still shows bright distracting areas after cropping local control in printing should be used This is commonly called dodging and consists of giving the offending bright areas additional exposure When enlarging, this "printing in" is accomplished by the manipulation of large sheets of black paper in which holes of suitable size have been cut These sheets are held a few inches above the photographic paper in such a position that the objectionable areas are given additional exposure The dodging material should be kept in constant motion to avoid sharp lines of demarcation In contact printing, the same effect is achieved by placing tissue paper on the glass shelves beneath the glass supporting the negative Holes of correct size and shape are cut in the tissues to give additional exposure to desired areas, which are positioned over the holes

The dodging procedure just described is used when the print shows local areas that are too light when the major portion of the print is of correct density see Figure 3 When the print is out of balance because certain *small* areas are too dark and the major portion is of desirable density it is better to "hold back" the darker areas than to "print in" the lighter portions. When enlarging this is effected through the use of small paddles made from wire and black paper As in "printing in" the dodging material is kept in motion a few inches above the photographic paper In contact printing the desired areas can be "held back" by penciling the tissue on the glass shelf of the printer or by adding pieces of tissue under the portion of the negative to be printed lighter The tissues can be marked for penciling or cutting by placing them on a sheet of glass laid over the negative on the printer thus making the areas needing modification easy to find

Another application of dodging is in connection with extremely contrasty subjects. When a soft paper is used in an attempt to retain detail in both shadow and highlight portions of negatives from such subjects the fine detail is frequently lost and the highlights have a smoky appearance By printing on more contrasty paper and adjusting the exposure for correct highlight density the condition is corrected so far as the highlights are concerned but shadow detail is lost By "holding back" the shadows in printing it is possible to produce a

CHAPTER X INFRARED TECHNIQUES

INFRARED photography of patients in medical research, education, and practice has been established mainly as a valuable supplement to the visual examination of superficial venous patterns. In addition, its ability to show detail under the skin has made it useful in other ways. It has already been employed in studying a variety of conditions and a reasonable assumption is that new applications will be found.

The value of infrared records depends a lot on the care with which the technique is carried out, especially when a series of pictures is made in studying progressive changes in a patient. This does not mean that the procedure is difficult: anyone experienced in ordinary medical photography can readily and confidently undertake it. And today the photographer has a great advantage over early workers in that the films available are faster than the older type plates. In applying the technic, it is important to understand what medical infrared photography can and can not do. With that in mind, the nature of infrared photography is briefly explained in the section dealing with its uses.

Nature and Uses

The characteristic of infrared radiation that makes it useful for medical photography is its property of penetrating the skin and the body tissues to a greater extent than visible light. There is some disagreement among workers in the field about what region of the spectrum affords maximum transmission. The evidence reviewed by Clark would indicate that it corresponds closely to the region of sensitivity of medical infrared films.

The greater portion of incident infrared radiation penetrates into the tissues and is reflected back diffusely by them. An infrared photograph of the body makes the

Weight for larger paper with a tough "folding" support for prints that will receive strenuous use

Choice of a contrast grade appropriate for the negative so as to provide a print with a full scale of tones ranging from black to white.

Development for the *full* time recommended by the manufacturer adequate but not too much fixing, and sufficient washing (see Chapter VIII)

Inspection for quality under suitable illumination—it should be similar in intensity and color to that in which the prints will ordinarily be viewed

Dodging only when the best possible results by straight printing are inadequate —to diminish the brightness of distracting areas, to improve visibility of detail in dark areas, or to increase the brilliance of fine detail in contrasty subjects by "adjusting" the negative to a suitable paper

A good print ranges from white to black tones with detail in both In general appearance it should be neither muddy nor harsh Its gradation in the middle tones should be such that an accurate visual impression of the original subject is given

Prints for Journal Illustration

Apart from the quality requirements of clinical prints mentioned previously there are certain requirements that if met will simplify the production of good journal illustrations The prints should be on 8 x 10-inch paper of a blue-black tone and with a glossy ferrotyped surface They should not be mounted unless a layout of several prints butted together is prepared by the photographer Then all the illustrations for that article should be on thin cards of the same thickness. Paper clips will leave marks that cannot be obliterated. The top and the figure number should be indicated in ink on the white margins. Captions with figure numbers should be separate from the prints White ink can be used to direct attention to faint details on the print and the caption should mention this to avoid *confusion*

Inexpert lettering or inclusion of arrows should not be done on the print the publisher s artist can do much better The position of such legends or keys, however can be indicated lightly on a tissue overlay gummed to the back of the print along one edge and folded over its face Such a tissue can also bear in simple terms instructions to the photoengraver regarding important areas and details to be brought out this is particularly important with medical photographs because the etcher cannot be expected to know the diagnostic signs and other subtle features of such complex pictures Use a very soft pencil so as not to dent the print with the writing Photographs worth making are worth heavy cardboard protection for mailing

CHAPTER X INFRARED TECHNIQUES

INFRARED photography of patients in medical research, education, and practice has been established mainly as a valuable supplement to the visual examination of superficial venous patterns. In addition, its ability to show detail under the skin has made it useful in other ways. It has already been employed in studying a variety of conditions and a reasonable assumption is that new applications will be found.

The value of infrared records depends a lot on the care with which the technique is carried out, especially when a series of pictures is made in studying progressive changes in a patient. This does not mean that the procedure is difficult; anyone experienced in ordinary medical photography can readily and confidently undertake it. And today the photographer has a great advantage over early workers in that the films available are faster than the older type plates. In applying the technic, it is important to understand what medical infrared photography can and can not do. With that in mind, the nature of infrared photography is briefly explained in the section dealing with its uses.

Nature and Uses

The characteristic of infrared radiation that makes it useful for medical photography is its property of penetrating the skin and the body tissues to a greater extent than visible light. There is some disagreement among workers in the field about what region of the spectrum affords maximum transmission. The evidence reviewed by Clark would indicate that it corresponds closely to the region of sensitivity of medical infrared films.

The greater portion of incident infrared radiation penetrates into the tissues and is reflected back diffusely by them. An infrared photograph of the body makes the

Weight for larger paper with a tough "folding" support for prints that will receive strenuous use.

Choice of a contrast grade appropriate for the negative so as to provide a print with a full scale of tones ranging from black to white.

Development for the *full* time recommended by the manufacturer adequate but not too much fixing and sufficient washing (see Chapter VIII)

Inspection for quality under suitable illumination—it should be similar in intensity and color to that in which the prints will ordinarily be viewed

Dodging only when the best possible results by straight printing are inadequate —to diminish the brightness of distracting areas to improve visibility of detail in dark areas or to increase the brilliance of fine detail in contrasty subjects by "adjusting" the negative to a suitable paper

A good print ranges from white to black tones with detail in both In general appearance it should be neither muddy nor harsh Its gradation in the middle tones should be such that an accurate visual impression of the original subject is given

Prints for Journal Illustration

Apart from the quality requirements of clinical prints mentioned previously there are certain requirements that if met will simplify the production of good journal illustrations. The prints should be on 8 x 10-inch paper of a blue-black tone and with a glossy ferrotyped surface. They should not be mounted unless a layout of several prints butted together is prepared by the photographer Then all the illustrations for that article should be on thin cards of the same thickness Paper clips will leave marks that cannot be obliterated The top and the figure number should be indicated in ink on the white margins Captions with figure numbers should be separate from the prints White ink can be used to direct attention to faint details on the print and the caption should mention this to avoid confusion

Inexpert lettering or inclusion of arrows should not be done on the print the publisher's artist can do much better The position of such legends or keys however can be indicated lightly on a tissue overlay gummed to the back of the print along one edge and folded over its face Such a tissue can also bear in simple terms instructions to the photoengraver regarding important areas and details to be brought out this is particularly important with medical photographs because the etcher cannot be expected to know the diagnostic signs and other subtle features of such complex pictures Use a very soft pencil so as not to dent the print with the writing Photographs worth making are worth heavy cardboard protection for mailing

engorgement, on the nearness of the veins to the surface the region of the body and on the condition of the vein walls. Because of variations in these factors Rosenbloom has suggested an ingenious norm for breast phlebograms—that of the patient herself photographed at an age before changes have probably occurred. In evaluating results, the following points should be studied. the shape of the venous pattern itself its distinctness or strength and changes in this respect in serial photographs, and the number of veins visualized.

The penetration of infrared radiation makes it of surprising value in photographing structures beneath an opaque cornea. The details, of course, do not photograph as sharply as they would if the cornea were clear

Infrared photographs cannot be made through a thick growth of hair Accordingly hair on the male thorax or on extremities must be removed before photography It must also be remembered that details underneath areas suffused with venous blood, such as often accompanies ulcers, will be more or less obscured.

Use of the technique to map the course and number of varicose and thrombotic veins is well known. In this way it is possible to obtain some estimation of the probable healing tendency of the ulcers and thus facilitate choice of treatment

Early malignant neoplasms on or near the body surface, such as Paget's disease of the nipple can be expected to show exaggerated and possibly abnormal markings of the surrounding zone that are indicative of the invariable increase in blood supply to tumor regions, see Figure 1 In this field, therefore the record is an additional tool in establishing the presence of a possible neoplasm, but, of course cannot encroach on biopsy as a diagnostic pro-

Figure X 2: Portal cirrhosis of liver with ascites, showing characteristic superficial venous changes (patient aged 37 years) *(Case and diagnosis courtesy of S. M Boston Jr., M.D.)*

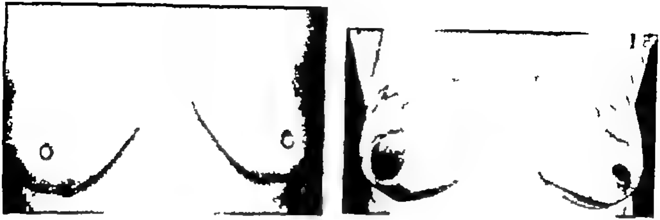


Figure X 1: Two cases that illustrate variations in the definiteness of venous patterns due to such factors as individual characteristics age and functional status: *LEFT* very early Paget's disease of left nipple (patient aged 62 years); note indications of increased blood supply to tumor region; *RIGHT* 3 months multipara aged 36 years with mild bilateral mastitis; observe prominent but otherwise normal pattern and some engorgement of areolae In comparing these two records notice that in the first case the pattern is weak in keeping with the patient's age and mammary involution; its significance lies in its asymmetry The strong pattern in the second case reflects mainly the patient's age and mammary activity rather than the presence of a serious pathologic condition *(Cases and diagnoses courtesy of S M Bouton Jr., M.D.)*

flesh look as though it were glowing faintly with a peculiar ashy gray pallor This appearance of the skin is true even of Negroes and suntanned persons

If this "glow" is obscured by an object that absorbs the radiation under the skin the object is recorded as a shadow unless it is so small that the radiation diffuses around it Obviously the nearer the object to the surface the sharper will be its shadow

Eggert showed that venous blood in vitro absorbs infrared radiation whereas arterial blood does not. Similar studies have been made by Merkelbach Barker and Julin earlier had recorded the venous pattern in patients by virtue of these facts They noted too that the beard below the skin of cleanshaven men could cast a shadow Massopust, and Gorman and Hirsheimer further demonstrated the ability of the technic to map the superficial veins. Atrophied areas in the iris and tattoo patterns obliterated on the surface of the body have also been found to cast shadows

While it is generally agreed that in the infrared photograph the veins are more noticeable than they are visually the pictures must not be expected always to show a striking network of veins Indeed it is a mistake to be disappointed when the pattern is not boldly delineated (See Figure 1) Its distinctness depends on the thickness of the skin on the degree of venous

lights for the lighting angles recommended are required. The reflectors should have a matte side which produces even illumination. They should be easily removed, which is an advantage in photographing the anterior segments of the eye.

Either 500-watt, PS-25, 3200° Kelvin Mazda lamps or No. 2 photoflood lamps are suitable for general use. However, photoflash lamps are almost a necessity in the photography of nervous patients, or in close-up photography when the pulsation of arteries adjacent to the veins, or involuntary movement such as that of the eyes, may otherwise blur the results. The No. 22 photoflash lamp is suggested for the purpose because it has ample light output and can be flashed on 110 volts. It fits the same sockets as the tungsten lamps mentioned and is therefore readily interchanged with them; it is, of course, necessary to arrange a means for flashing several photoflash lamps at one time.

For infrared photographs of the eye, a single SM photoflash lamp is recommended because the duration of its flash is short enough to make open-flash procedure feasible. It must be flashed on three to six volts in a stand light connected to a plug that has been wired to a dry cell, or in a synchronizer.

A dimmer provides two conveniences: it permits reducing the brightness and heat of tungsten lamps during the preparations prior to exposure; it may also be used as an electrical outlet for firing several photoflash lamps together.

Electronic flash lamps are suitable alternatives because of their coolness, speed, and convenience. They should be equipped with modeling lights. In considering electronic flash lamps, however, it cannot be assumed that their output of useful infrared radiation is directly related to the exposure levels they provide in photography with visible light.

The following specific data will be useful as a guide for the calibration of individual setups. With Kemlite 225T electronic flash tubes impressed with 225 watt seconds each from a power pack, housed in compact "home-portraiture" reflectors and placed in a "four-corner" arrangement, the aperture is f/22 when the lamps are 42 inches from the subject. This corresponds approximately to a guide number of 45 for each lamp when Kodak Infrared Film and the No. 87 filter are used. This also comes to half the intensity of No. 22 photoflash bulbs, see Table IX, page 178.

Films and Filters

For medical infrared photography, Kodak Infrared Sheet Film is supplied in regular sizes for sheet film cameras and Kodak Infrared Film in miniature sizes and IR116, IR616, IR120, IR620 and IR127 six-exposure rolls. The complete specifications of these films and their applications are to be found in the Kodak Data Book on *Infrared and Ultraviolet Photography*.

In addition to their sensitivity to infrared radiation, infrared films are sensitive to blue and to part of the visible red region

cedure Its usefulness in determining a primarily vascular nature of an otherwise known superficial neoplasm is obvious and beyond question

Several published accounts of the use of infrared photography deal with attempts to develop a differential diagnostic aid relative to cirrhosis of the liver hepatic carcinosis etc One fact stands out as being significant in this respect In incipient cirrhosis there may be no recognizable collateral circulation whereas the finding of a well-developed collateral venous pattern in advanced liver disease indicates or confirms for all practical purposes the presence of cirrhosis (See Figure 2.)

The foregoing has dealt with some clinical aspects with a full realization that for teaching purposes it has additional value in demonstrating superficial circulatory anatomy Obviously then these capabilities of the technique requires that large and small areas of the body have to be carefully photographed in order to produce useful results

Equipment and Materials

Most cameras commonly used for clinical photography are practicable but two points are worth consideration in choosing one (1) In general a fairly large negative image is required in order to record the finest detail accordingly a 4 x 5-inch camera is the first choice (2) Focusing is simplest with view cameras which permit moving the back independently of the lens

The camera bellows must not transmit infrared radiation Those who have not tried the technique had best check on this matter and also on the safety of the dark slides if sheet film is used To test the bellows, the camera should be loaded with infrared film and a safe dark slide partially withdrawn or with roll film cameras, a frame wound into place Then the bellows should be subjected to the illumination it would normally receive If no line of demarcation shows on the film after it has been developed, the bellows is safe

The suitability of dark slides can be determined by loading each holder with infrared film and placing a piece of metal about half the size of the film on the slide. The latter is then exposed for about a minute to the light of a 100-watt lamp located a few inches away If upon development, the film does not show a light patch where the metal lay the slide is safe The dark slides on holders manufactured by the Eastman Kodak Company and Graflex Incorporated have *five* dots embossed on them to indicate that they are suitable for infrared photography Metal slides are also safe

Lights

A sufficient number of lights capable of producing broad even illumination is needed Two pairs of lights provide a highly adaptable outfit for evenly lighting *the torso or extremities* Three pairs are required for the entire body Lights which permit ready positioning of the individual

of the spectrum. Hence appropriate filters must be employed for infrared photography. The Wratten No. 87 Filter (infrared) absorbs the blue and the visible red and is best suited to emphasizing venous detail. Somewhat less emphasis results when the Wratten No. 25 Filter (red) is utilized because it absorbs only the blue component of the reflected light. Since the red component is unaffected, only half the exposure required for the No. 87 Filter is needed. This is useful when more depth of field or a faster shutter speed is wanted than is possible with the No. 87 filter.

Background Materials

Painted walls, window shades, or many of the backgrounds ordinarily used in clinical photography can be utilized. Some pigments may photograph darker or lighter than their visual appearance. This can be checked by making photographic tests.

It is advisable to use a material that *prints* black or almost so rather than one that *is* black, otherwise troubles in making prints may be encountered. (See pages 170 and 162.) To obtain a gray tone in the print, backgrounds of gray or light green sheeting are useful. If space permits, the same result can be accomplished by placing a white sheet at some distance behind the patient, where it receives low illumination.

Lighting

The function of infrared photography is that of depicting the shadowy forms of veins embedded in the body tissues. It is vital to avoid, as much as possible, surface shadows from contrasty lighting, edge shadows, and diffuse reflections from improper placement of the lights. Thus, there are two requirements in the illumination employed—evenness and the correct lighting angles. The extreme importance of these two factors is illustrated in Figure 3. A large percentage of the faults seen in unsuccessful infrared photographs can be traced to neglect of these principles. (A special problem is involved in photographing the eye since the number and positions of the corneal reflections affect clarity.)

Evenness

Flat, even lighting calls for an adequate number of lights, an equal amount of illumination on both sides of the camera-subject axis, and proper distribution of the lighting over the subject.

One light on each side is sufficient for small regions such as the thigh, lower leg, or forearm. Four lights, two on each side, should be employed for entire extremities, the thorax or abdomen, or the torso. For a full-length photograph, six lights are required. In photographing the anterior segments of the eye, it is desirable to employ a single light; this results in only one corneal reflection, though a slight, but usually unimportant, unevenness is present.

When pairs of lights are used, they must all be of the same wattage, and, in most

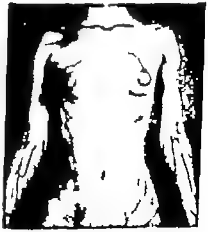
A

B

Figure X-3 *Demonstrating importance of using exact lighting in infrared photography* *A* and *B* were made with the same illumination The modeling used was acceptable for panchromatic film *A* but the *unevenness though slight* resulted in a worthless infrared record *B* Uniform vertical lighting was used for *C* *D* and *E* but the horizontal lighting angles were varied The rendition *C* shows the appear*ance of infrared records made* with too small a horizontal angle; note outline shadow and central diffuse reflection *D* shows the bright outline and central shadow caused by too large an angle *E* depicts the *excellent rendition of detail* obtained with the correct angle (*55*)

C

D



E

of the spectrum. Hence appropriate filters must be employed for infrared photography. The Wratten No. 87 Filter (infrared) absorbs the blue and the visible red and is best suited to emphasizing venous detail. Somewhat less emphasis results when the Wratten No. 25 Filter (red) is utilized because it absorbs only the blue component of the reflected light. Since the red component is unaffected, only half the exposure required for the No. 87 Filter is needed. This is useful when more depth of field or a faster shutter speed is wanted than is possible with the No. 87 filter.

Background Materials

Painted walls, window shades, or many of the backgrounds ordinarily used in clinical photography can be utilized. Some pigments may photograph darker or lighter than their visual appearance. This can be checked by making photographic tests.

It is advisable to use a material that *prints* black or almost so rather than one that *is* black, otherwise troubles in making prints may be encountered. (See pages 179 and 182.) To obtain a gray tone in the print, backgrounds of gray or light green sheeting are useful. If space permits, the same result can be accomplished by placing a white sheet at some distance behind the patient, where it receives low illumination.

Lighting

The function of infrared photography is that of depicting the shadowy forms of veins embedded in the body tissues. It is vital to avoid as much as possible surface shadows from contrasty lighting, edge shadows, and diffuse reflections from improper placement of the lights. Thus, there are two requirements in the illumination employed—evenness and the correct lighting angles. The extreme importance of these two factors is illustrated in Figure 3. A large percentage of the faults seen in unsuccessful infrared photographs can be traced to neglect of these principles. (A special problem is involved in photographing the eye since the number and positions of the corneal reflections affect clarity.)

Evenness

Flat, even lighting calls for an adequate number of lights, an equal amount of illumination on both sides of the camera subject axis, and proper distribution of the lighting over the subject.

One light on each side is sufficient for small regions such as the thigh, lower leg, or forearm. Four lights, two on each side should be employed for entire extremities, the thorax or abdomen, or the torso. For a full length photograph, six lights are required. In photographing the anterior segments of the eye, it is desirable to employ a single light: this results in only one corneal reflection, though a slight, but usually unimportant, unevenness is present.

When pairs of lights are used, they must all be of the same wattage and, in most

instances must be placed at equal distances from the subject. An exception to this rule may be necessary in photographing the entire body in which case the lights directed toward the lower extremities usually should be about 20 per cent closer than the others

In distributing the lighting it is essential to remember that most lights provide a circular *pattern of illumination* usually with a central zone of greatest intensity—the "hot spot" They must be used far enough away from the patient and be so directed as to spread the illumination evenly and completely over the appropriate area As a safety measure against the illumination falling off at the edges of the field, it is advisable to spread the zones over an *area somewhat larger than the* region studied As an example of how the lighting is distributed the setup for photography of the torso or abdomen (Figure 4 Setup I page 174) can be considered The diagram indicates that the two lights located above the camera level and the two below it are adjusted so that the four zones are not superimposed on the center of the torso Rather *the lights are so aimed* that the zones from the top two together and the bottom two together overlap like a squat figure-8 somewhat larger than the area For smaller regions like the lower leg, the zones from the two lights required can be superimposed or at most, they need be separated only a trifle In aiming the lights, each lamp ought to be turned on separately

LIGHTING ANGLES

The term "lighting angle" as used here means the angle between the lamp-subject axis and the lens subject axis. Obtaining correct angles is a matter of positioning the lights In the horizontal plane the lighting angle (which is, of course, the same on both sides of the camera) must be just *great enough to illuminate* the lateral aspects of the subject It must not be so small as to cause a great deal of diffuse reflection in the direction of the camera These points are demonstrated in Figure 3

The size of the horizontal angle adopted is governed by the shape of the surface being photographed A convex surface necessitates a horizontal angle of about 55 degrees (*Figure 4 Setups I and III*) *On the* other hand, a concave surface may require a *horizontal angle of only* about 40 degrees to preclude the formation of an undesirable shadow at the bottom of the concavity Thus, for lighting the entire female thorax, horizontal angles of both 40 degrees and 55 degrees are needed (See Figure 4 Setup II) The setups can be *applied in photographing similar structures*

Vertical angles must be provided by separating the lights vertically The size of the vertical angle is not as critical as that of the horizontal and depends largely on the vertical separation obtainable with the lights at hand *an angle of 30 degrees is* generally feasible and is sufficient Vertical angles should usually be the same above

and below the camera-subject axis. However, in photographing the medial aspect of the thigh, with the other leg raised, this is not practicable. The lamp nearer the posterior plane of the leg has to be the higher of the two in order to avoid a shadow from the extended leg. This lamp cannot be placed at the usual vertical angle because of the shadow that would be cast by the intervening buttock. The angle should, however conform as closely as possible to the one suggested.

In arranging lights for photography of the entire body the torso should first be lighted in the way shown in the general setup. Then, the extra pair of lights required for the lower extremities must be placed at the camera level and directed downward toward the knees. A 45- to 55-degree horizontal angle should be adopted, the size of the angle depending on the lighting facilities and on the amount of edge-lighting desired. In infrared photography of the anterior segment of the eye the light usually should be located at the camera level and the lighting angle adjusted to position the highlight so that it does not obscure visualization of the iris or other areas of interest.

Tungsten and electronic flash illumination presents no problem in aiming the lights. To obtain suitable lighting directions with photoflash lamps, however it is first necessary to adjust the lights to the proper angles with the tungsten bulbs in place. These should then be replaced by the photoflash lamps for the exposures.

It is fully realized that some difficulty will be encountered in applying standard lighting plans to nonambulatory patients. Nevertheless, the basic principles can be followed under most circumstances. That is, whenever the patient has to assume a position other than the vertical, the lighting setup must be changed accordingly so that the light will fall on the body as it would in the standard (vertical) plan. For example, in photographing the recumbent patient, one unit should be placed at each side of the bed and the lights raised by means of the telescoping column to provide the correct lighting angle. Photography of such a patient is facilitated by having him lie on the lowest support available.

Lamp Distances

Specific lamp-to-subject distances that will answer for most of the regions commonly photographed are given in Figure 4 (page 174) and Table IX. Any necessary variations can be worked out on the basis of two broad requirements. (1) The lamp-to-subject distance should be such as to provide a central bright zone of a size suitable for the area, as explained on page 172. (2) The lights should be as close as the patient will tolerate because any infrared sensitive material is relatively slow.

Placement of the lights as close as is compatible with the preceding requirements will lead to the best delineation of the veins. This is probably due to the fact that lights at close range provide effectively

instances must be placed at equal distances from the subject. An exception to this rule may be necessary in photographing the entire body in which case the lights directed toward the lower extremities usually should be about 20 per cent closer than the others

In distributing the lighting it is essential to remember that most lights provide a circular pattern of illumination, usually with a central zone of greatest intensity—the "hot spot" They must be used far enough away from the patient and be so directed as to spread the illumination evenly and completely over the appropriate area. As a safety measure against the illumination falling off at the edges of the field, it is advisable to spread the zones over an area somewhat larger than the region studied As an example of how the lighting is distributed the setup for photography of the torso or abdomen (Figure 4 Setup I page 174) can be considered The diagram indicates that the two lights located above the camera level and the two below it are adjusted so that the four zones are not superimposed on the center of the torso Rather the lights are so aimed that the zones from the top two together and the bottom two together overlap like a squat figure-8 somewhat larger than the area. For smaller regions like the lower leg, the zones from the two lights required can be superimposed or at most, they need be separated only a trifle. In aiming the lights each lamp ought to be turned on separately

Lighting Angles

The term "lighting angle" as used here means the angle between the lamp-subject axis and the lens subject axis Obtaining correct angles is a matter of positioning the lights In the horizontal plane the lighting angle (which is, of course, the same on both sides of the camera) must be just great enough to illuminate the lateral aspects of the subject It must not be so small as to cause a great deal of diffuse reflection in the direction of the camera These points are demonstrated in Figure 3.

The size of the horizontal angle adopted is governed by the shape of the surface being photographed A convex surface necessitates a horizontal angle of about 55 degrees (Figure 4 Setups I and III) On the other hand, a concave surface may require a horizontal angle of only about 40 degrees to preclude the formation of an undesirable shadow at the bottom of the concavity Thus for lighting the entire female thorax, horizontal angles of both 40 degrees and 55 degrees are needed (See Figure 4 Setup II) The setups can be applied in photographing similar structures

Vertical angles must be provided by separating the lights vertically The size of the vertical angle is not as critical as that of the horizontal and depends largely on the vertical separation obtainable with the lights at hand an angle of 30 degrees is generally feasible and is sufficient Vertical angles should usually be the same above

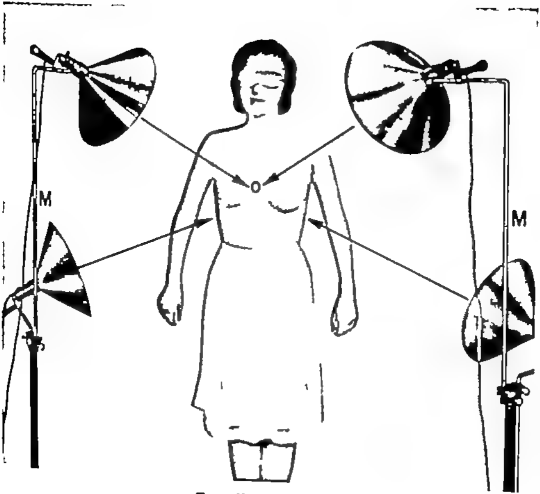


Figure X-4: Setup II

→

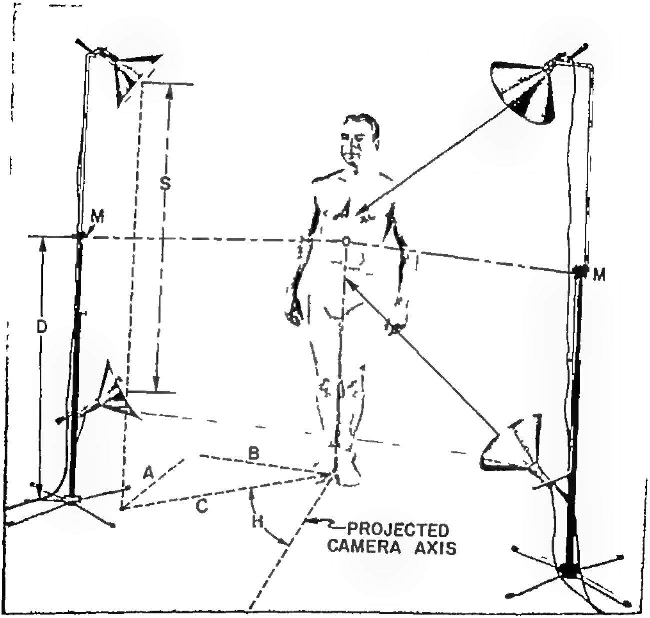


Figure X-4 Setup I

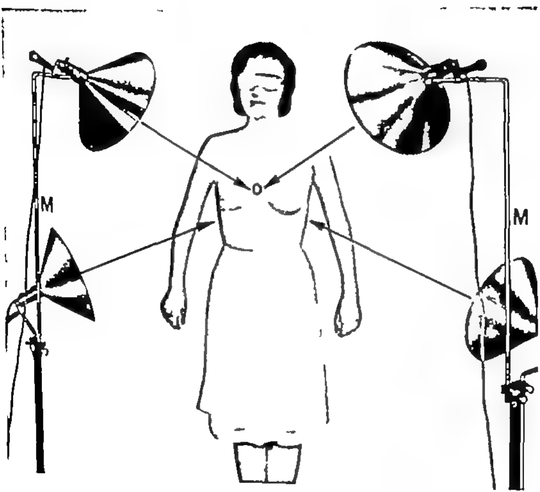


Figure X-4: Setup 11

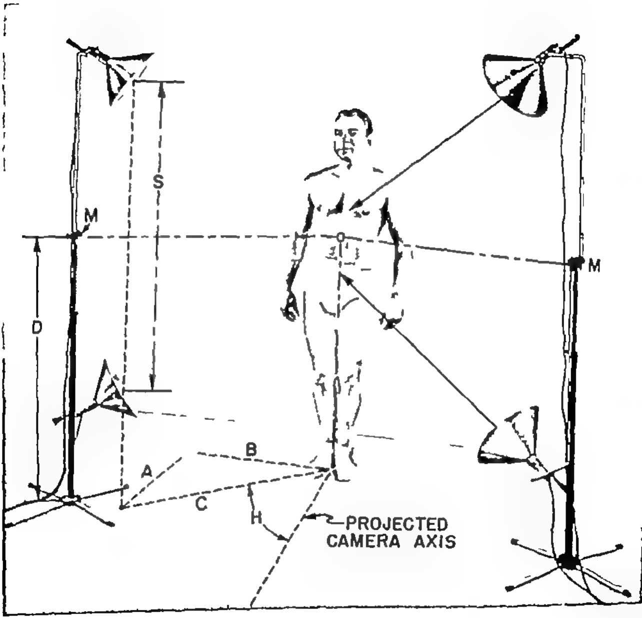


Figure X-4 Setup I

larger sources, and hence introduce less surface modeling than they would if placed at some distance. As a general rule the lamps should be located closer than the camera to the patient.

Because of the vertical lighting angles involved, it is best to establish lamp distances by measuring their positions as though they were dropped to the floor. (A plumb-bob is useful for locating the lamps over the floor plans shown in Figure 4, or drawing, page 178.) The distances given in Table IX were measured on this basis. While the actual lamp-to-subject distances are somewhat greater, the effect on exposure is negligible.

Setting Up

It is desirable to obtain the cooperation of the patient so that the best position for steadiness and for adequate lighting of a specific area can be achieved. The position of the patient as it affects the use of a suitable background must be considered, too. In general, the procedures of ordinary clinical photography can be adopted. The following specific suggestions are worth keeping in mind.

Positioning of Patient

The four positions that may be assumed for photographs of the torso or the abdomen, in order of their ease in lighting, are standing erect, sitting erect on a stool, semirecumbent in a wheel chair, and supine or laterally recumbent in bed. For photographing the anterior and lateral aspects of the thorax, either erect position is good. A standing patient can be steadied by having him grasp the back of a chair at his side.

In photographing clavicular, axillary, and mammary regions, the sitting-erect posture is best since subject motion is relatively easy to control. To show the axilla, the arm should be raised in maximum extension; the forearm can be rested across the top of the head for comfort and steadiness. To provide best presentation of the areolar areas of ptotic breasts, the patient should rest both arms across the top of the head, see Figure 5. For the superior surfaces see Figure V-3, page 81.

When the upper extremity is photographed, it should be allowed to hang downward with the patient leaning sideways toward the member. This measure prevents the side of the body from obtruding into the field of view. It is sometimes necessary to steady the arm by resting the fingertips on a firm object such as the seat of a chair; see Figure V-4, page 83.

A standing position is best for all photographs of the lower extremities. Presenting their various aspects entails no special problems in positioning the patient, with the exception of the medial aspect of the thigh. In this instance the most satisfactory method is to turn the patient sideways and to raise the intervening leg. The patient can be steadied quite readily if the extended foot is placed on the seat of a

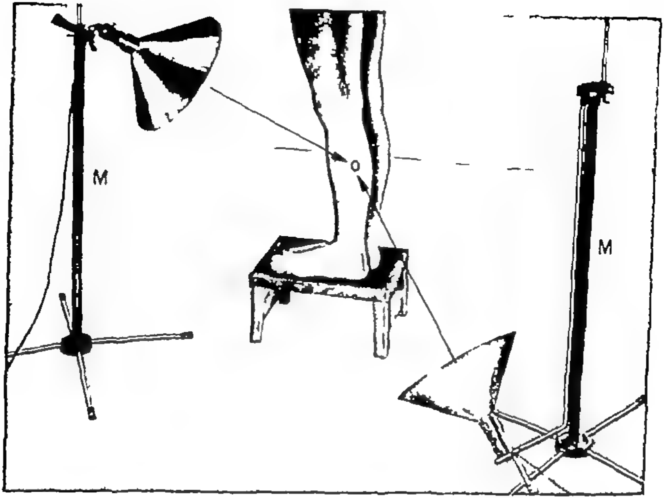


Figure X-4: Setup III

Figure X-4 Photodiagrams of generalized lighting arrangements *Setup I* for male and female torso or abdomen *Setup II* for female thorax *Setup III* for lower leg Suggested steps are as follows: Measure distance D Temporarily place patient aside Locate camera lens and M at height D Arrange lights to provide vertical separation S Place lights at horizontal angle H Position patient and aim individual lights Make exposure This procedure can be most conveniently carried out if the location for the patient X and horizontal lighting axes C are permanently marked on the floor as indicated in the floor plan at the left If permanent markings are not adopted dimensions A and B given in the table below can be used to locate the lights each time a setup is made The separation S to provide vertical lighting angles can be readily made by equally dividing the separation at M The same rules apply even in setups in which only one light is used on each side Exposures are calculated from distances C (Because of the vertical angle involved C is less than the actual distance between lamp and subject but the difference is negligible)

larger sources, and hence introduce less surface modeling than they would if placed at some distance. As a general rule the lamps should be located closer than the camera to the patient.

Because of the vertical lighting angles involved, it is best to establish lamp distances by measuring their positions as though they were dropped to the floor (A plumb-bob is useful for locating the lamps over the floor plans shown in Figure 4, or drawing, page 178.) The distances given in Table IX were measured on this basis. While the actual lamp-to-subject distances are somewhat greater the effect on exposure is negligible

Setting Up

It is desirable to obtain the cooperation of the patient so that the best position for steadiness and for adequate lighting of a specific area can be achieved. The position of the patient as it affects the use of a suitable background must be considered, too In general, the procedures of ordinary clinical photography can be adopted. The following specific suggestions are worth keeping in mind.

Positioning of Patient

The four positions that may be assumed for photography of the torso or the abdomen, in order of their ease in lighting, are standing erect, sitting erect on a stool, semirecumbent in a wheel chair and supine or laterally recumbent in bed. For photographing the anterior and lateral aspects of the thorax, either erect position is good. A standing patient can be steadied by having him grasp the back of a chair at his side.

In photographing clavicular axillary and mammary regions, the sitting-erect posture is best since subject motion is relatively easy to control. To show the axilla, the arm should be raised in maximum extension the forearm can be rested across the top of the head for comfort and steadiness To provide best presentation of the areolar areas of ptotic breasts, the patient should rest both arms across the top of the head, see Figure 5. For the superior surfaces see Figure V-3, page 81

When the upper extremity is photographed, it should be allowed to hang downward with the patient leaning sideways toward the member This measure prevents the side of the body from obtruding into the field of view It is sometimes necessary to steady the arm by resting the fingertips on a firm object such as the seat of a chair see Figure V-4, page 83.

A standing position is best for all photography of the lower extremities. Presenting their various aspects entails no special problems in positioning the patient with the exception of the medial aspect of the thigh. In this instance the most satisfactory method is to turn the patient sideways and to raise the intervening leg The patient can be steadied quite readily if the extended foot is placed on the seat of a

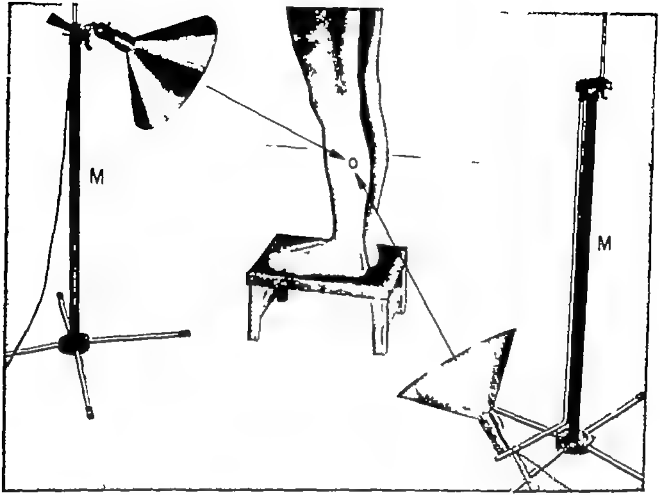


Figure X-4 Setup III

Figure X-4: Photodiagrams of generalized lighting arrangements *Setup I* for male and female torso or abdomen *Setup II* for female thorax *Setup III* for lower leg Suggested steps are as follows: Measure distance D Temporarily place patient aside Locate camera lens and M at height D Arrange lights to provide vertical separation S Place lights at horizontal angle H Position patient and aim individual lights Make exposure This procedure can be most conveniently carried out if the location for the patient X and horizontal lighting axes C are permanently marked on the floor as indicated in the floor plan at the left If permanent markings are not adopted dimensions A and B given in the table below can be used to locate the lights each time a setup is made The separation S to provide vertical lighting angles can be readily made by equally dividing the separation at M. The same rules apply even in setups in which only one light is used on each side Exposures are calculated from distances C (Because of the vertical angle involved C is less than the actual distance between lamp and subject but the difference is negligible)

For photographing any aspect of the thigh and for the posterior aspect of the lower leg, the extremity can be raised as far as possible and steadied by an assistant. The leg should be lowered for a few minutes just before making the exposure to allow return of the blood supply that would have partially drained from the veins during focusing. For photographs of the lateral, medial, and anterior aspects of the lower leg, the member need not be extended but the knees should be drawn up as far as possible in order to simplify directing the camera.

Tensing the muscles in the extremities is a procedure often practical for emphasizing the venous pattern. It can be accomplished by having the patient clench the fist or stand on tiptoe for about ten seconds just prior to the exposure. The application of a tourniquet (under proper supervision, of course) can be adopted to provide regional emphasis.

Occasionally the character and contour of the surfaces make localized direct and diffuse highlights and dark shadows unavoidable in spite of careful lighting. If they obscure important detail, it is necessary to vary the position of the patient and make enough photographs to provide a complete record of the detail desired.

Background Tone

The greatest fault with many medical infrared photographs is a blending of the dark edges of the subject into a black background or into the shadows on a light background. In most cases this fault can be avoided by following the lighting recommendations given previously and thereby minimizing the outline shadows. (See Figure 3, page 170.)

In general, a dark background should be selected because it has three advantages. First, shadows from the subject are not noticeable in a print with a dark background, whereas they often cause confusing patterns on light backgrounds. Second, a dark background can be located close to the patient, which reduces the space

Figure X 5: Infrared record of the breasts and the upper part of the chest made with the compact "home-portraiture" stand type of electronic flash lighting. A four-corner arrangement of the lamps was adopted (see text). The patient was sitting erect with her hands on her head. The camera was raised to about shoulder height and directed downward toward the sternum so that the upper part of the chest was parallel to the film plane.

TABLE IX

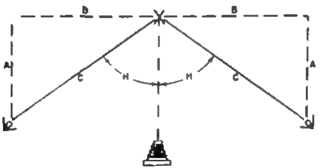
EXPOSURE DATA FOR INFRARED PHOTOGRAPHY*

REGION	NUMBERS OF LAMPS	LAMP DISTANCE	EXPOSURE	
			For 500-watt, 3200°K Lamps	For No. 22 Photoflash Lamps
Trunk, Thorax, Abdomen, Entire Extremity	4†	42 in	1/2 sec. at f/11	Open flash at f/32
Thigh, Forearm,	4	24 in	1/5 sec. at f/11	Open flash at f/45
Lower Leg	2	28 in.	1/2 sec. at f/11	Open flash at f/32
Hand, Axilla, Clavicular area	2	18 in.	1/5 sec. at f/11	Open flash at f/45

Based on use of matte side of reflectors and Kodak Infrared Sheet Film or Kodak Infrared Film, with Wratten No. 87 Filter over lens. Data given for white skin. For Negroid or deeply suntanned skin or pigmented areas multiply exposures by 2

† Lamps directed so that central zones of illumination are partially overlapped, give ½ stop less exposure for smaller areas at this distance when all zones are superimposed.

When photoflash lamps are used close to patient it is extremely important that adequate protection be provided for those present against accidental explosion of the bulb as a result of the flash.



chair and the patient is supported from behind. It is also possible for an assistant to bear the weight of the extended foot on his knee and to steady the patient by grasping both hands, see Figure V-5 page 84

Should the condition of the patient preclude a standing posture for photography of the legs, a supine position is feasible

For photographing any aspect of the thigh and for the posterior aspect of the lower leg, the extremity can be raised as far as possible and steadied by an assistant. The leg should be lowered for a few minutes just before making the exposure to allow return of the blood supply that would have partially drained from the veins during focusing. For photographs of the lateral, medial, and anterior aspects of the lower leg, the member need not be extended but the knees should be drawn up as far as possible in order to simplify directing the camera.

Tensing the muscles in the extremities is a procedure often practical for emphasizing the venous pattern. It can be accomplished by having the patient clench the fist or stand on tiptoe for about ten seconds just prior to the exposure. The application of a tourniquet (under proper supervision, of course) can be adopted to provide regional emphasis.

Occasionally the character and contour of the surfaces make localized direct and diffuse highlights and dark shadows unavoidable in spite of careful lighting. If they obscure important detail, it is necessary to vary the position of the patient and make enough photographs to provide a complete record of the detail desired.

Background Tone

The greatest fault with many medical infrared photographs is a blending of the dark edges of the subject into a black background or into the shadows on a light background. In most cases this fault can be avoided by following the lighting recommendations given previously and thereby minimizing the outline shadow. (See Figure 3, page 170.)

In general, a dark background should be selected because it has three advantages. First, shadows from the subject are not noticeable in a print with a dark background, whereas they often cause confusing patterns on light backgrounds. Second, a dark background can be located close to the patient, which reduces the space

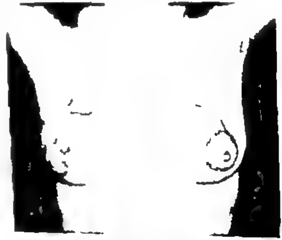


Figure X 5. Infrared record of the breasts and the upper part of the chest made with the compact "home-portraiture" stand type of electronic flash lighting. A four-corner arrangement of the lamps was adopted (see text). The patient was sitting erect with her hands on her head. The camera was raised to about shoulder height and directed downward toward the sternum so that the upper part of the chest was parallel to the film plane.

needed for photography Third, the outline of the patient can be most readily depicted against a dark background—important when regional edema or ridging of the veins is a significant feature.

A light background is useful chiefly when a 40-degree lighting angle is found necessary Then the unavoidable outline shadow on the subject does not blend into a light background as much as it does into a dark one. Disturbing shadows on a light background can be minimized by placing the patient about 40 inches from it In this way most of the shadows are cast outside the camera field Dark gray backgrounds are best when enlargments are the usual infrared records that are produced Black backgrounds are suitable when only ordinary contact prints are to be made from the negatives

When a patient is bedridden or in a wheel chair the background is quite close to him It is worth while to place the patient on a dark cloth if good edge lighting is attainable When a white sheet is the only feasible background it should be made as smooth as possible some shadows may have to be tolerated

Composing and Focusing

The axis of the camera should be aimed nearly perpendicular to the center of a curved surface or at a slight angle to a fairly flat surface The area included in the field of view should be large enough to provide easy identification of the anatomy

For focusing in some instances, an increase in bellows extension may have to be made because the lens produces an infrared image that comes to a focus appreciably behind the visible image Some lenses have a special index mark on the focusing scale to facilitate infrared focusing

When the increase needed is not known it is sometimes helpful to focus the image visually with a Wratten No 25 Filter (red) placed over the lens or held before the eye As a general rule, the increase can be taken as one-quarter per cent of the bellows extension required for the visible focus. When photography at 1/4 scale or larger is undertaken this increase should be made by moving the back of the camera—not the lens. However if the back of the camera cannot be moved independently of the lens the same purpose can be accomplished closely enough by moving the entire camera away from the subject a distance equal to the increase required divided by the magnification of the image

For most subjects the lens will have to be stopped down to at least f/11 so that sufficient depth of field is provided This procedure also helps to offset differences between the visual and the infrared focus

In testing the equipment or the focusing technic for infrared photography sharpness should be gauged from the rendition of hairs, pores or marks placed on the patient's skin for the purpose The image of the veins is not a suitable guide since they

be beneath the skin and cannot be sharply recorded.

Exposing and Processing Film

Medical infrared photography is a relatively high-contrast process; accordingly exposures are somewhat more critical than those for ordinary black-and-white photography. Exposures are given in Table IX, page 178. They can also be determined from exposure meter readings. The Film Exposure Index for Kodak Infrared Film used in medical photography is 4. Both the table and the index given here are based on the use of a Wratten No. 87 Filter over the lens. When a Wratten No. 25 Filter is utilized, the exposures should be halved. Data for four lamps included in Table IX can be applied without change for using six lamps in photographing the entire body provided the lighting suggested on page 174 is adopted.

The table also gives data for Photoflash illumination in photography of regions other than the eye. For the surface of the eye an open-flash technic with SM lamps is quite convenient. At a scale of 1/1 this lamp should be placed 6 inches from the eye and a lens aperture of f/8 employed. (When photoflash lamps are used close to patients, it is extremely important that adequate protection be provided for those present against accidental explosion of the bulb as a result of the flash.)

Since pigmented skin affects the infrared reflectivity of the subject slightly, allowance for this should be made in exposing. For Negro patients or skin showing deep suntan, or pigmented areas around varicose ulcers, the exposure times given in the table should be increased by a factor of 2, but those calculated from an exposure meter need not be changed.

PROCESSING

The processing of infrared film is a straightforward procedure. As recommended in the instructions packed with the film, total darkness is preferable for both loading and processing, although the Wratten Safelight Series 7 can be used with care.

For medical work a fairly high develop-

Figure X-6: The flesh tones on an infrared negative should look darker than those of an ordinary negative. The density of the veins will depend upon the strength at which they photograph. This is the appearance of the negative from which Figure 5 was printed when placed on the Kodak Transparency Illuminator.

ment contrast is required Accordingly Kodak Infrared Sheet Film should be developed in Kodak DK-50 at 68 F (20 C) for 9 minutes in a tray or 11 minutes in a tank. Kodak Infrared Film (in rolls) requires development in Kodak D 76 for 16 minutes in a tank at 68 F (20 C)

A correctly exposed and processed infrared negative resembles a somewhat over exposed and flat ordinary negative (Figure 6) *Attempts to make infrared negatives look like regular negatives will result in poor delineation*

Making Prints

When making prints from infrared negatives it is often difficult to judge the correct printing density and contrast because of the inherent unnaturalness of the flesh tones in an infrared rendition The general tendency is to make the prints too dark and lacking in contrast If the main purpose of the technique—depicting venous detail—is kept in mind it is relatively easy to learn to print just dark enough to record the faintest veins and just contrasty enough to show them clearly This principle can be utilized, of course when details other than veins are to be brought out—for example atrophied areas in the iris An easily remembered rule is *Print for the detail and ignore flesh tones*

In enlarging from infrared negatives made with a black background or one that prints deep black trouble from flare may be encountered with some enlargers The reason is that the negative bears a very dense image in the center of an almost clear area The way to minimize the effect is to employ the stray light masks in the enlarger closed to as small an area as possible Also the lens must be clean If the fault persists it is best to procure for subsequent work a background that prints dark gray so that the density range between the subject and the surrounding area will be reduced on the negative

When serial photographs are made to study variations in the engorgement of veins by virtue of the definiteness with which they are recorded, it is extremely important to use the same grade of paper throughout Dodging should not be resorted to since it might introduce artifacts For many other routine prints however dodging is valuable to prevent shadowed areas from becoming too dark

Reading Negatives

For most applications it is entirely practical to make photographic prints that satisfactorily record the findings qualitatively These can be filed with the histories to show the general aspects of the cases However they may not fill all needs because slight variations in printing exposure can introduce artifacts due to inconsistent print quality Therefore it is worth while to consider the routine reading of infrared negatives for certain applications particularly when research is to be undertaken

Standardized negatives are relatively

simple to make. Also it is a well established fact that it is possible to see greater detail in a transparency than in the dark portions of a print of suitable contrast. It is the author's experience that this principle applies equally well when viewing infrared negatives from evenly lighted medical subjects. Accordingly, for quantitative studies, the following suggestion is offered.

Whenever a series of infrared records is made for the purpose of studying many examples of a condition or for relating various conditions, the physician, in cooperation with a competent photographer, could well learn to judge the records from the *negatives*. This is the way in which radiographs are read and it would seem a valuable way in which to interpret many aspects of infrared records. Prints of course would be helpful for general guidance in studying the venous distribution—the negatives would show the fine differences between cases.

In a project of this nature, it is extremely important to adopt a standardized lighting setup for the subjects. Also, consistent exposure and developing procedures for the negatives must be followed. Viewing should be done on the same illuminator throughout. Stray light should be masked from around the edges of the negatives.

References

BARKER, N. W., and JULIUS, L. A.: Demonstration of Superficial Veins by Infra-Red Photography. *Proc. Staff Meet. Mayo Clin.*, 9:68-70, January 31, 1934.

BEAN, W. B.: A Note on Infrared Photography of Cutaneous Arterial "Spiders" and Hereditary Hemorrhagic Telangiectases. *J. Lab. & Clin. Med.*, 30:190-19.., February, 1945.

BLAKEMORE, A. H., and LORD, J. W., Jr.: A Nonsuture Method of Blood Vessel Anastomosis. Part II. *J.A.M.A.*, 127:748-753, March 31, 194[?].

BOWES, K.: Clinical Aspects of Infrared Photography. *Phot. J.*, 90B:63-65, May-June, 1950.

CLARK, WALTER: *Photography by Infrared.* Chapman & Hall, Ltd., London, 1939.

DEKKING, H. M.: Infrarotphotographie des Auges. II. Mitteilung: Das Pigment. *Arch. f. Ophth.*, 131:20-25, 1934.

DENT, R. V.: The Photographic Aspect of Light Reflection From Human Skin. *J. Lab. & Clin. Med.*, 26:1852-1862, August, 1941.

EGGERT, J.: Fortschritte und Grenzleistungen in der Infrarot-Photographie. *Veröff. wiss. Zentral-Lab. Agfa*, 4:101-118, 1935.

EPSTEIN, BERNARD S.: Infrared Photographic Demonstration of the Superficial Venous Pattern in Congenital Heart Disease with Cyanosis. *Am. Heart J.*, 18:2..-259, September, 1939.

FELDMAN, J. B.: A Review of Infra-Red Photography With Reference to Its Value in Ophthalmology. *Arch. Ophth.*, 15:435-44.., March, 1936.

FRIEDMAN, JOEL, LITE, THEODORE, and FECHTNER, HERBERT A.: Infrared Photography of the Oral Mucosa. *New York J. Dent.*, 29:7-13, January, 1959.

GORSLEY, W. A., and HIRSCHHEIMER, A.: A Study of the Superficial Venous Pattern in Pregnant and Non-Pregnant Women by Infra-Red Photography. *Surg. Gynec. & Obst.*, 68:54-6.., January, 1939.

HAXTHAUSEN H : Infrared Photography of Subcutaneous Veins : Demonstration of Concealed Varices in Ulcer and Eczema of the Leg. *Brit J Dermat., 45* 506-511 December 1933

JANKELSON I R., and BAKER, H : Infra Red Photography of Abdominal Wall in Portal Cirrhosis of Liver *Am J Digest Dis 5* 414-418 September 1938

JANKELSON I R., ZAMCHECK, N and BAKER, H Symposium on Cirrhosis of the Liver Correlation between Needle Biopsy of the Liver and Infrared Photography of the Abdomen in Cirrhosis of the Liver *Am J Gastroenterol 21* 9-2, 1954

JONES, E *Demonstration of Collateral Venous* Circulation in the Abdominal Wall by Means of Infra Red Photography *Am J M Sc., 190* 478-485 October 1935

JÖRG M *Über weitere Anwendungen der Ultrarotphotographie in Kriminalistik und Medizin. Phot Korr 74* 148-150 September 1938

KAPLAN T Thrombosis of the Axillary Vein *Report of Five Cases with Comments on* Etiology Pathology and Diagnosis. *J.A.M.A., 110* 2059-2064 June 18 1938

KAUFMAN PAUL A Subcutaneous Phlebitis of the Breast and Chest Wall *Ann. Surg., 144* 847-853, November 1956

MANN W A., JR. Infra Red Photography of the Eye. *Arch Ophth 13*·985-991 June 1935

MASSOPUST L. C. Infra Red Photographic Study of the Changing Pattern of the Superficial Veins in a Case of Human Pregnancy *Surg., Gynec & Obst.,* 63 86-89 July 1936

MASSOPUST L. C. Infrared Photographic Study of the Superficial Veins of the Thorax in Relation to Breast Tumors *Surg Gynec & Obst., 86* 54-58 January 1948.

IDEM An Application of Infrared Photography *Med. Radiog & Photog., 23* 23, 1947

MASSOPUST LEO C., and GARDNER, WESTON D : The Infrared Phlebogram in the Diagnosis of Breast Complaints. *Surg., Gynec & Obst., 97*·619-626 November 1953

MERKELBACH, O Das infrarote Spektrum von Hämoglobin, von Blutfarbstoffderivaten und von Pigment (Dopamelanin) *Ztschr Angew. Phot 1* 33-42, April, 1939

PAYNE, R T Infra Red Photography of the Superficial Venous System. *Lancet 1* 235-238, February 3 1934

RONCHESE, F Infra Red Photography in the Diagnosis of Vascular Tumors *Am J Surg., 37* 475-477 September 1937

ROSENBLOOM MONROE A. *Infrared Photography* of the Female Breast. *Surg Gynec & Obst.,* 2:603-610 December 1953.

SHIPINER, L. B : Arteriovenous Aneurysm of the Axillary *Artery* and *Vein* Caused by a Gunshot Wound. *Military Surgeon 101* 23-26 1947

STEWART H J., CRANE, N F., and DEITRICK, J E. Studies of the Circulation in Pericardial Effusion *Am Heart J 16* 189-197 August, 1938

WAYBURN E Infra Red Photography of the Abdominal Wall *Am J Digest Dis., 9* 392-394 November 1942.

WILSON E E The Changes in Infra Red Photographs Taken During the Treatment of Varicose Veins *Amer J Surg 37* 470-474 September 1937

The author wishes to acknowledge the invaluable help received from the text and illustrations adapted from *Medical Radiography and Photography*. He is also grateful to the Rochester General Hospital, Strong Memorial Hospital and Saint Mary's Hospital in Rochester for making available to him their clinical facilities.

HAXTHAUSEN H Infrared Photography of Subcutaneous Veins Demonstration of Concealed Varices in Ulcer and Eczema of the Leg. *Brit J Dermat* 45 506-511 December 1933

JANKELSON I R., and BAKER, H Infra Red Photography of Abdominal Wall in Portal Cirrhosis of Liver *Am J Digest Dis.*, 5 414-418 September 1938

JANKELSON I R., ZAMCHECK, N., and BAKER, H Symposium on Cirrhosis of the Liver Correlation between Needle Biopsy of the Liver and Infrared Photography of the Abdomen in Cirrhosis of the Liver *Am. J Gastroenterol*, 21 9-2, 1954

JONES, E. *Demonstration of Collateral Venous* Circulation in the Abdominal Wall by Means of Infra Red Photography *Am J M Sc.*, *190* 478-485 October 1935

JÖRG M Über weitere Anwendungen der Ultrarotphotographie in Kriminalistik und Medizin *Phot Korr.*, *74* 146-150 September 1938

KAPLAN T Thrombosis of the Axillary Vein Report of Five Cases with Comments on Etiology Pathology and Diagnosis. *J.A.M.A.*, *110* 2059-2064, June 18 1938

KAUFMAN PAUL A. Subcutaneous Phlebitis of the Breast and Chest Wall. *Ann. Surg.*, *144* 847-853 November 1956

MANN W A., JR. Infra Red Photography of the Eye. *Arch Ophth* *13* 985-991 June, 1935

MASSOPUST L. C. Infra Red Photographic Study of the Changing Pattern of the Superficial Veins in a Case of Human Pregnancy *Surg Gynec & Obst* 63 86-89 July 1936

MASSOPUST L. C. *Infrared Photographic Study* of the Superficial Veins of the Thorax in Relation to Breast Tumors *Surg Gynec & Obst.*, 86 54-58 January 1948

IDEM An Application of Infrared Photography *Med Radiog. & Photog.*, 23 23, 1947

MASSOPUST LEO C. and GARDNER, WESTON D The Infrared Phlebogram in the Diagnosis of Breast Complaints. *Surg Gynec & Obst.*, 97 619-626, November 1953

MERKELBACH, O Das Infrarote Spektrum von Hämoglobin von Blutfarbstoffderivaten und von Pigment (Dopamelanin) *Ztschr Angew Phot.*, *1* 33-42, April, 1939

PAYNE, R T Infra Red Photography of the Superficial Venous System. *Lancet* *1* 235-236, February 3 1934.

RONCHESE, F Infra Red Photography in the Diagnosis of Vascular Tumors. *Am J Surg.*, *37* 475-477 September 1937

ROSENBLOOM MONROE A Infrared Photography of the Female Breast. *Surg., Gynec & Obst.*, *2* 603-610 December 1953

SHENNER L. B Arteriovenous Aneurysm of the Axillary Artery and Vein Caused by a Gunshot Wound *Military Surgeon, 101* 23-26 1947

STEWART H J CRANE, N F and DEITRICK, J E. Studies of the Circulation in Pericardial Effusion *Am Heart J* *16* 189-197 August, 1938

WATBURN E. Infra Red Photography of the Abdominal Wall. *Am J Digest Dis.* 9 392 394 November 1942.

WILSON E. E The Changes in Infra Red Photographs Taken During the Treatment of Varicose Veins *Amer J Surg* 37 470-474 September 1937

The author wishes to acknowledge the invaluable help received from the text and illustrations adapted from *Medical Radiography and Photography*. He is also grateful to the Rochester General Hospital, Strong Memorial Hospital and Saint Mary's Hospital in Rochester for making available to him their clinical facilities.

INDEX

D